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THE CONDOR

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THE CONDOR

VOLUME 54 MAY-JUNE, 1952 NUMBER 3

THE INCUBATION PATCH OF PASSERINE BIRDS

By ROBERT E. BAILEY

Shortly before incubation in most groups of birds the down feathers of one or more areas of the ventral surface are molted and the skin of these areas becomes thickened and richly supplied with blood vessels. This adaptation facilitates the transfer of heat from the body of the incubating bird to the eggs; thus these areas are called incubation patches.

Incubation patches were first described at length by Friedrich Faber (1826) in his book on water birds of northern Europe. He named them "Brutflecke" and rightly ascribed to them the function of permitting a more intimate contact between the incubating birds and their eggs. The absence of feathers was considered by him to be the main criterion of an incubation patch and he thought that the feathers were either pulled out by the birds or were lost partly because of the abrasive action of the nest and eggs and partly because of the "greater animal heat that is concentrated in the abdomen during incubation" [translated]. Barkow (1830) was the first to examine the microscopic structure of the incubation patch and compare it with normal skin. His work was done on the European Coot, grebes of the genus *Podiceps* [=*Colymbus*], and chickens. A lack of feathers and greatly increased vascularity were described by him as the main features of the structure.

Little work on the incubation patch was done, except for occasional references to its occurrence, until the first of the twentieth century. Interest in the evolution of the mammary glands led to a study of the incubation patch by Lange (1928), and his work is a considerable contribution to our knowledge of the microscopic and macroscopic structure of the patches in the several groups that he investigated. The work of Freund (1926) and of Koutnik (1927) concerned mostly the histological changes that occur in the formation of the incubation patch, but their work was restricted almost entirely to domestic fowl.

Incubation patches are found in almost all orders of neognathous birds. They are similar in their function and basic structure but differ in size, location, and number. The chief and most obvious characteristic of all incubation patches is the absence of feathers so that there exists at the time of incubation a naked place on the skin which can come into direct contact with the eggs. Such a loss of feathers seems necessary if the higher body temperature of birds is to be utilized to its fullest capacity in providing a constant, warm environment for the eggs, since feathers are poor conductors of heat. Usually only down feathers are lost, but in some groups contour feathers are also molted so that the patches are enlarged or two patches may be united to form a single large patch. In some orders no down feathers are found in the apteria and thus naked spaces are always present. These, however, should not be considered as incubation patches unless the other characteristics are also observed.

Since incubation patches occur almost exclusively in the apteria, it is to be expected that feather arrangement will have a strong effect on the position and number of the patches. By far the most common condition is a single patch located in the ventral

apterium. It is referred to as the median patch and is usually limited in size by the extent of the ventral apterium, although in some groups it is enlarged by a loss of contour feathers. A single median patch is found in the Colymbiformes (grebes), Procellariiformes (petrels, fulmars, albatrosses), Falconiformes (hawks), Columbiformes (pigeons and doves), Strigiformes (owls), and in all the so-called higher orders of birds such as the Passeriformes (song birds) and Piciformes (woodpeckers). Lateral patches occur in some of the groups which have a very narrow ventral apterium and lateral apteria of considerable size. These patches are always paired and lie in the region lateral to the main ventral feather tract. Lateral patches occur in the Charadriiformes (gulls, shorebirds, auks), Galliformes (pheasants, quail, and grouse), and Gruiformes (rails, cranes). They may or may not be accompanied by a median patch. In the Galliformes both lateral and median patches are present and originate separately but soon unite into a single large patch by a loss of contour feathers in between. No patches have been found in the ratite birds, the Pelecaniformes (pelicans), or the Anseriformes (ducks, geese, swans).

All incubation patches show increased dermal and subdermal vascularity. There is not only an increase in the size and number of capillaries and smaller veins and arteries but also an increase in the size of the larger vessels supplying the incubation patch region. In this way a capillary bed forms just under the epidermis and the radiation and conduction of heat from the incubating bird to the eggs is enhanced. Dermal edema accompanies and perhaps results from the increased vascularity. It is difficult to ascribe any functional significance to the edema, and detailed investigation aimed at this particular response will probably be necessary to determine its relationship to the incubation patch as a whole. In addition to the responses already mentioned there is usually a disappearance of feather papillae, dermal muscles, and subdermal fat.

Incubation patches are found in both males and females according to their participation in incubating the eggs. Insufficient data are available to state definitively the situation in all of the living orders. Certain trends, however, can be noted with reservations. In most orders both sexes incubate and both sexes have incubation patches. This is true for the Colymbiformes, Procellariiformes, Columbiformes, Piciformes, most Charadriiformes, and most Gruiformes. Only females incubate and have patches in the Strigiformes, Falconiformes, Trochilidae, and most, if not all Passeriformes. Only males incubate and have patches in the Phalaropidae, Jacanidae, and some Scolopacidae.

The theory that the birds pull out their feathers to form the incubation patch was attacked by Lange. He believed that the loss of feathers was due to a special molt and cited as evidence the presence of patches in an immature gull (*Larus ridibundus*) that did not breed. These patches were identical in size and location with those of the breeding gulls and he attributed their occurrence to a hormonal influence. The fact that the patches in any one species are always found in the same location and are of the same size is further evidence that the defeatherization is not due to a haphazard plucking of the feathers by the birds.

The purpose of this investigation has been to study through various attacks the nature of the incubation patch in the order Passeriformes. Both field and laboratory work has been carried on and much has been added by the combination of the disciplines of natural history and physiology.

Acknowledgements.—I am extremely grateful to Dr. Oliver P. Pearson of the Museum of Vertebrate Zoology, under whose guidance this study was carried out, for his constant aid and encouragement. I am also indebted to Dr. William R. Lyons of the Division of Anatomy, University of California, and Dr. Alden H. Miller, for their help and guidance. To my many associates at the Museum of Vertebrate Zoology I record

with pleasure appreciation for their aid in collecting and obtaining specimens and for the opportunity of gleaning from their field notes much important information on the occurrence of the incubation patch. The prolactin (Leuteotropin Squibb) used was kindly furnished by E. R. Squibb and Sons. The estradiol (Progynon) and the testosterone (Oreton-F) were kindly furnished by the Schering Corporation, Bloomfield, New Jersey. The research was supported in part by a fellowship from the Bank of America-Giannini Foundation.

FIELD STUDY

MATERIALS AND METHODS

For the study of the microscopic and macroscopic structure of the incubation patch in passerine birds 125 specimens representing 12 families were examined. All these were collected in California or Nevada. In addition, data for six more families were obtained from the literature and from field notes deposited in the Museum of Vertebrate Zoology. Whenever possible both members of a nesting pair were collected and every effort was made to obtain complete information about the reproductive activities of the birds. In many instances it was possible to locate the nest and to determine the age of the young or eggs. On other occasions it was necessary to estimate the stage of the reproductive cycle by examining the gonads.

Several pairs of nesting birds were marked with colored bands for closer observations. These were trapped and examined daily and the changes in the structure of the incubation patch were correlated with the events of the nesting cycle. Only a few pairs were studied in this manner, but satisfactory information about the duration of the various stages of the incubation patch was obtained for the White-crowned Sparrow (*Zonotrichia leucophrys*), Oregon Junco (*Junco oreganus*), and Song Sparrow (*Melospiza melodia*).

A complete series of the various incubation patch stages was obtained and studied microscopically. Pieces of the skin of the incubation patch were removed from freshly killed birds, fixed in Bouin's fluid or 10 per cent formalin, sectioned at three to 10 microns, and stained with Delafield's hematoxylin and eosin or Mallory's stain.

MACROSCOPIC STRUCTURE

The incubation patch of passerine birds presents no exception to the general rule that the most important factor regulating the size, number, and location of the incubation patches is the arrangement of the feathers on the ventral surface. In passerine birds the ventral feather tract divides in the neck region into two symmetrical branches that continue posteriorly to the cloaca. These branches diverge rapidly and on the breast and abdomen are widely separated. They are broad on the breast but narrow sharply at the anterior edge of the abdomen. The apterium that they enclose medially is broad and proportionately much larger than that found in most orders of birds. It is covered sparsely with down feathers, especially on the abdomen (fig. 1).

The incubation patch is located within the large ventral apterium and is in fact coincident with it. It extends from the anterior edge of the breast to the cloaca and laterally to the median edge of the ventral feather tracts. All the down feathers in the apterium are molted in the first stage of the development of the patch. During incubation it is vascular and edematous; the skin appears reddish in color and is considerably thickened. No contour feathers are lost in the formation of the incubation patch of passerine birds.

The blood supply of the patch of passerines shows no marked deviations from that found in other groups. It was described adequately by Lange (1928) and I have examined only a few birds in this regard. Some minor variations exist, but for the most part only three main sources are important in relation to the incubation patch.

The breast region is supplied by two branches of the external thoracic artery. One becomes subcutaneous in the shoulder and continues posteriorly along the median edge of the ventral feather tract. It sends branches into the feather tract and into the ventral apterium. The second becomes subcutaneous under the ventral feather tract about midway along the breast. It also sends branches to the ventral feather tract and to the breast region of the ventral apterium. The arteria incubatoria, which is an important vessel

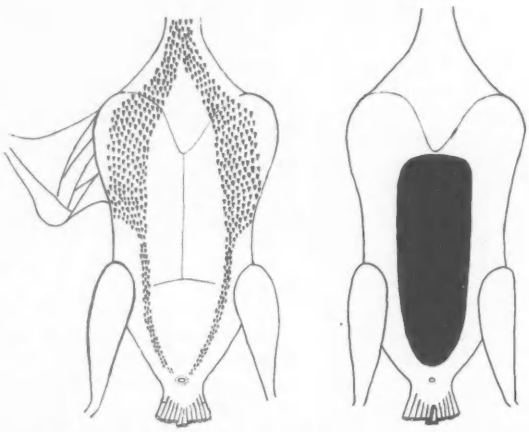

Fig. 1. Ventral surface of White-crowned Sparrow showing relationships of the ventral feather tracts and ventral apterium (left) to incubation patch (right; black area).

in the blood supply of the incubation patch in many groups of birds, runs lateral to the ventral tract and sends no significant branches medially. It therefore plays no important role as a vessel supplying the incubation patch of passerine birds.

The abdominal part of the ventral apterium is supplied by one or more branches of the prepubic artery. This artery is a branch of the internal pelvic and is so named because it runs ventral to the pubis and then enters the abdominal musculature. From the abdominal wall several branches become subcutaneous and these provide the chief supply for the skin of this region.

MICROSCOPIC STRUCTURE AND CORRELATION OF THE INCUBATION PATCH STAGES WITH THE REPRODUCTIVE CYCLE

The nesting cycle of all passerine birds that incubate their own eggs can be divided into several stages representing various behavioristic and physiological activities. The pattern is fairly uniform and consists of (1) courtship and territory formation (if such occurs), (2) nest building (during which time copulation usually occurs several times), (3) egg laying, (4) incubation, (5) brooding, (6) fledging, and (7) either a return to the non-reproductive condition or resumption of the cycle at the nest building or egg laying stage. Variations exist in the duration of each stage in the different species but all of them usually occur in all passerine birds in the order named with the exception of those showing brood parasitism.

The incubation patch of passerine birds also undergoes a series of changes that can be divided into several stages. These stages can be related to the stages of the nesting cycle and in fact both probably owe their appearance to the same physiological activi-

ties. The incubation patch stages and their correlation with the nesting cycle stages are diagrammed in figure 2. The diagram is based on the White-crowned Sparrow, but since the variations that exist are due to the differences in the length of the stages, it applies, except for time, to all the passerine birds observed.

During the non-breeding season the skin of the abdomen and breast is similar to the skin of other parts of the body. It is thin and for the most part only loosely fastened to the body wall. The stratum germinativum of the epidermis is made up of 1 to 3 layers of rather flattened cells and is covered externally with a thin stratum corneum. The dermis, as in mammals, is divided into a compact and a spongy layer. The compact layer consists of a closely packed mass of connective tissue fibers lying parallel to the surface. Wherever down feathers occur the compact layer follows the papilla down into the spongy layer. The spongy layer is a looser connective tissue that contains the larger arteries and veins of the skin. It is difficult to distinguish the boundary between the spongy layer of the dermis and the subdermal tissue. In passerine birds the subdermis

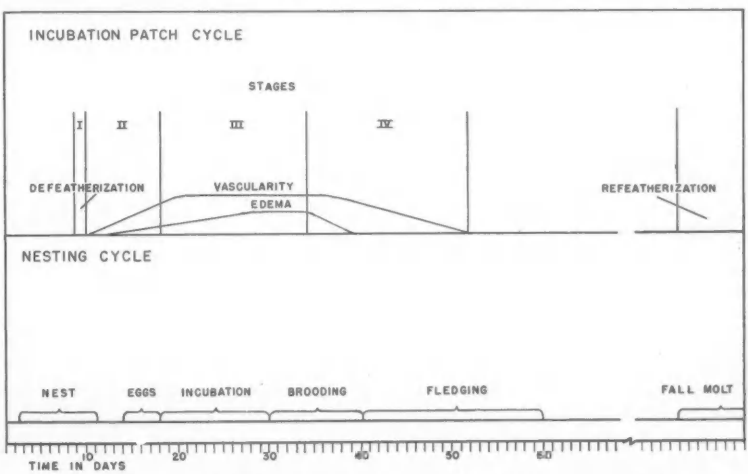

Fig. 2. The stages of the incubation patch cycle of the White-crowned Sparrow.

does not contain much adipose tissue, although usually some fat is concentrated under the feather tracts and under the skin of the abdomen, neck, and rump in preparation for migration. Figure 3 (*a-f*) shows some photomicrographs of the abdominal skin at various stages of the incubation patch cycle.

Stage I: Defeatherization.—Several days before the first egg is laid the down feathers of the ventral apterium are molted. This is the first change detectable in the formation of the incubation patch and the process requires about 24 hours for completion. Histological studies at this time show no changes in the structure of the skin. In the White-crowned Sparrow and Oregon Junco defeatherization occurs four to five days before the first egg. Nice (1937) reports the appearance of the incubation patch in the Song Sparrow four to six days before the first egg, and I assume from my studies that she was referring to defeatherization.

Many attempts were made to determine if the feathers were ever plucked out by the birds. Most passerines do not use feathers for the construction of their nests and thus

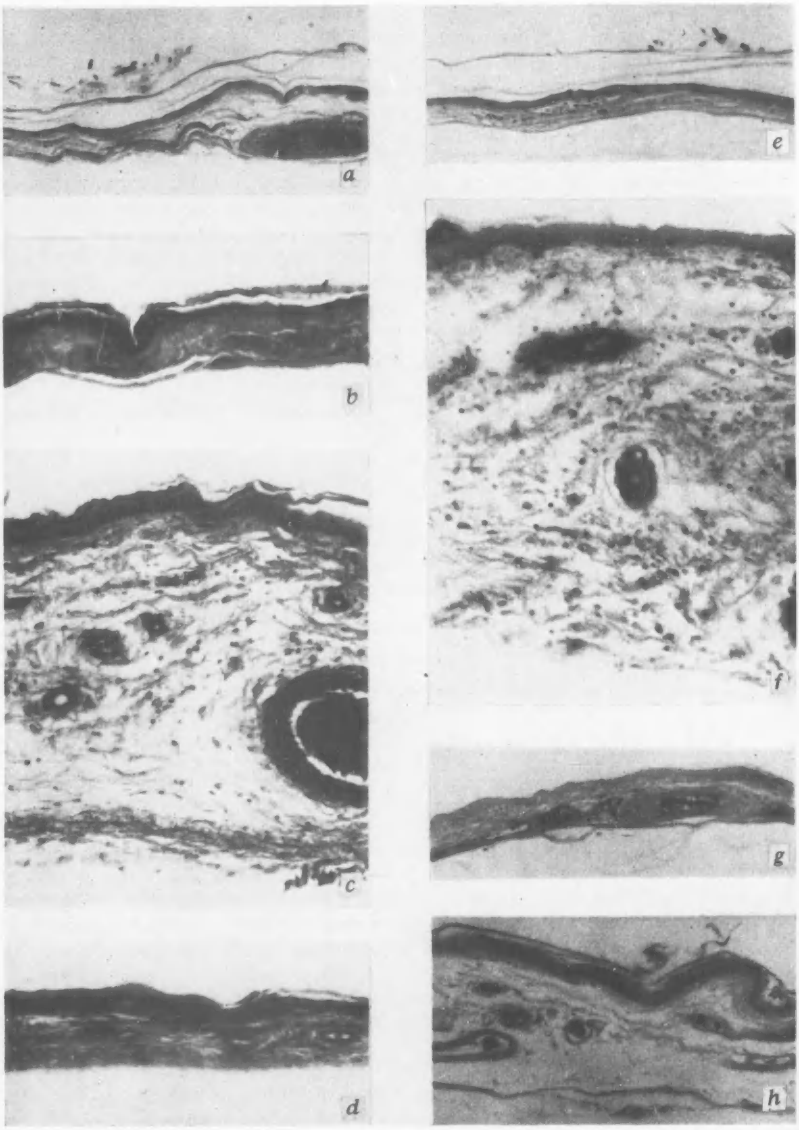

Fig. 3. Abdominal skin at various stages of the incubation patch cycle. Red-winged Blackbird: *a*, non-breeding (down feather papilla shows at right); *b*, after laying first egg; *c*, early incubation; *d*, young just out of nest. White-crowned Sparrow: *e*, non-breeding; *f*, after one week incubation; *g*, non-breeding hypophysectomized ♀ with estradiol for 9 days; *h*, non-breeding hypophysectomized ♀ with estradiol for 9 days then prolactin and estradiol for 8 more days. All × 160.

would not pull out their feathers for this reason. Never was I able to see any bird pluck feathers from its breast or abdomen nor did I see any bird with feathers in its mouth. I am convinced that the loss of down feathers in the ventral apterium during incubation is due to a special molt.

Stage II: Vascularization.—Immediately following defeatherization the blood vessels in the dermis of the ventral apterium begin to increase in size and number. By the time the last egg is laid and incubation begins, the skin is vascular and the many large blood vessels can be seen with the naked eye. In the White-crowned Sparrow this vascularization stage lasts about nine days. Toward the last of the vascularization stage a slight amount of edema occurs in the dermal tissue and a thickening of the skin results.

A section through the skin of the ventral apterium in this stage reveals a marked increase in the number of capillaries and smaller blood vessels as well as an increase in the size of the major vessels supplying the region. The edema, which will become even more marked in the next stage, is also readily noticeable microscopically. All feather papillae have already disappeared, but dermal muscle bundles can still be seen since they usually persist until the tissue is very edematous. Also, during this period, the cells of the stratum germinativum of the epidermis undergo rapid multiplication, are larger than before, and have rounder nuclei.

Stage III: Edema.—During incubation the patch continues to become more vascular and edematous, and the skin is now many times thicker than in non-breeding birds. When incubating, the female fluffs out the feathers that surround the incubation patch and the loosely folded skin is closely applied to the eggs. Thus the warmth brought to the surface of the incubation patch by the rich blood supply is efficiently transferred to the eggs. The edematous stage continues throughout the period of incubation and during the brooding of the newly hatched young. The length of incubation and brooding in the various species, therefore, is the important factor controlling the duration of this stage.

Stage IV: Recovery.—After the eggs are hatched and the young are no longer dependent on the parent for the maintenance of their body temperature as earlier, the vascularity and edema in the dermis begin to subside. This is a gradual process and usually begins when the young are about four or five days old. The edema disappears more rapidly than the vascularity. The skin, which has been somewhat stretched, is now wrinkled and scaly. The large blood vessels, no longer obscured by the edema, now stand out prominently but these also decrease in size and by the time the young are ready to leave the nest have almost returned to normal.

In many species of passerine birds a second clutch of eggs is laid after the first brood has been fledged. In such cases the incubation patch again becomes vascular and edematous as in the first cycle and continues to remain this way throughout the incubation and brooding of the second nesting. After the last clutch the skin of the abdomen and breast soon returns to normal but remains unfeathered, however, until the fall molt. During the period between nesting and the fall molt it is difficult to distinguish the site of an old incubation patch from the unfeathered ventral apterium of an immature bird.

OCCURRENCE OF THE INCUBATION PATCH

My study of the occurrence of the patch in passerine birds has been restricted almost entirely to the suborder Passeres and includes only one family (Tyrannidae) from the other suborders. An incubation patch was found in all nesting females that I examined but never have I found an incubation patch on a male passerine bird. The following is a list of the species of passerine birds of which I have personally examined males and females during the breeding season:

Tyrannidae
Black Phoebe (*Sayornis nigricans*)
Western Flycatcher (*Empidonax difficilis*)
Hirundinidae
Cliff Swallow (*Petrochelidon pyrrhonota*)
Corvidae
Scrub Jay (*Aphelocoma coerulescens*)
Steller Jay (*Cyanocitta stelleri*)
Clark Nutcracker (*Nucifraga columbiana*)
Paridae
Mountain Chickadee (*Parus gambeli*)
Plain Titmouse (*Parus inornatus*)
Bush-tit (*Psaltriparus minimus*)
Sittidae
Pygmy Nuthatch (*Sitta pygmaea*)
Chamaeidae
Wren-tit (*Chamaea fasciata*)
Turdidae
Robin (*Turdus migratorius*)
Vireonidae
Warbling Vireo (*Vireo gilvus*)
Parulidae
Orange-crowned Warbler (*Vermivora celata*)
Audubon Warbler (*Dendroica auduboni*)
Ploceidae
English Sparrow (*Passer domesticus*)
Icteridae
Red-winged Blackbird (*Agelaius phoeniceus*)
Brewer Blackbird (*Euphagus cyanocephalus*)
Western Meadowlark (*Sturnella neglecta*)
Fringillidae
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Purple Finch (*Carpodacus purpureus*)
House Finch (*Carpodacus mexicanus*)
Green-backed Goldfinch (*Spinus psaltria*)
Green-tailed Towhee (*Chlorura chlorura*)
Spotted Towhee (*Pipilo maculatus*)
Brown Towhee (*Pipilo fuscus*)
Oregon Junco (*Junco oreganus*)
Chipping Sparrow (*Spizella passerina*)
White-crowned Sparrow (*Zonotrichia leucophrys*)
Fox Sparrow (*Passerella iliaca*)
Song Sparrow (*Melospiza melodia*)

The incubation patch of all birds represents a series of structural and physiological changes that are closely correlated with the events of the nesting cycle. There is little doubt that these changes are functionally significant and that the incubation patch is important for the warming of the eggs. There is a high correlation in most orders between the presence of the patch and the share of the sexes in incubation. One would expect that in the passerine birds there would also be this correlation. The situation in this order, however, is complicated by the fact that, while in most instances the female alone incubates, the male may occasionally sit on the eggs and in some species does so regularly. From this it would appear that an incubation patch is not essential for the incubation of the eggs, but a closer examination of the facts does not bear out this assumption.

In the Wren-tit (*Chamaea fasciata*) and the Black-headed Grosbeak (*Pheucticus melanocephalus*) both sexes sit on the eggs in turns during the day, but the careful studies of the Wren-tit by Erickson (1938) and of the Black-headed Grosbeak by Weston (1947) show that it is always the female at night. It is, of course, during the night that the eggs are most likely to drop to such a low temperature that the development of the embryos may be impaired. At this time the adaptations which make the incubation patch especially efficient for the transferring of heat to the eggs are most needed. In the species in which only the female incubates, she may leave the nest frequently for feeding and drinking during the day; yet the eggs are not harmed. The activities of the male, therefore, in sitting on the eggs, is probably not absolutely essential. These questions can only be answered by a study of the temperature relationships involved.

LABORATORY STUDY

For reasons mentioned at the beginning of this paper it seemed obvious that the incubation patch develops in response to some internal stimulus and not to the mechanical action of the eggs against the feathers and skin. The loss of feathers is also certainly due to a special molt since they are not, except in the Anseriformes, plucked

out by the incubating birds. It occurred to me, therefore, that it might be possible to analyze the physiological mechanisms that control the development of the patch and through the manipulation of non-breeding birds to produce an incubation patch experimentally.

Since the incubation patch is directly concerned with reproduction, it was natural to turn first to the reproduction hormones as a promising approach to this study. Endocrines had already been suggested by Koutnik (1927) and Tucker (1943), but so far as I know no experiments had been made to determine which hormones are involved.

Several facts were useful in choosing hormones that might most profitably be studied. In 1935, Riddle, Bates, and Lahr found that prolactin, an anterior pituitary hormone, would induce broodiness in fowls. Prolactin is also associated with other "care of the young" responses such as lacation in mammals, crop sac secretion in pigeons and doves, maternal behavior in rats, and nest building in some fishes (see Riddle, 1935; Beach, 1948). It seemed likely, therefore, that prolactin might be able to regulate the development of the incubation patch as well as to cause broodiness. Ability, or lack of ability, to secrete this hormone could then account for the occurrence of the patch in various species and in one sex or the other. It could also explain the high degree of correlation between the occurrence of the patch and the urge to incubate.

The secretion of the gonads, that is, estrogens and androgens, seemed likely alternate factors since from studies of the nesting birds it was found that the first indications of the patch were observable in the latter part of the nest-building activities or shortly before ovulation. At this time the gonads are most highly developed and the estrogen and androgen titers would probably be at the highest. Presence or absence of the patch could then be explained by the ability of the ventral skin to respond. Possibilities that pituitary hormone other than prolactin might be involved and that perhaps the response might be initiated by the synergistic action of two or more hormones were considered.

MATERIALS AND METHODS

Only general materials and methods are given here. Deviations will be noted in the detailed description of the individual experiments. Three species of fringillid birds were used: White-crowned Sparrow, House Finch, and Oregon Junco. All were trapped on the University of California Campus, Berkeley, and were confined in groups of four in cages 12 by 12 by 12 inches or in groups of up to 12 in cages 2 by 2 by 3 feet. The birds were provided with a plentiful supply of water, bird seeds, and grit. Occasionally pears, apples, grapes, or lettuce were added to the diet. The smaller cages were kept indoors in a well ventilated room with a large window and were exposed to normal day lengths. The larger cages were placed out-or-doors in a sheltered area.

Estrogen Administration. Estrogen was administered as estradiol pellets (Progynon Schering). At first these were placed in the abdominal cavity but since it was impossible to watch the rate of absorption they were implanted in the neck region in the later experiments. This area was chosen because the pellets could be inserted in the incision used for hypophysectomy. It provided furthermore an access to the blood stream that did not immediately pass through the hepatic portal system and thus to possible deactivation in the liver.

Androgen Administration. Androgen was given as testosterone pellets (Oreton-F Schering) in the same manner as the estrogen.

Prolactin Administration. Luteotropin Squibb was injected subcutaneously in the rump or shoulder region. The dosage was the same in all of the experiments—30 I.U. (as 0.150 ml. of aqueous solution) daily.

Albumin Administration. Albumin was injected into a few birds serving as controls

for those treated with prolactin. This was administered as 0.150 ml. of 2 per cent aqueous solution injected subcutaneously in the rump or shoulder.

Hypophysectomy. The pituitary, both anterior and posterior lobes, were removed from some of the birds by a method modified from that of Schooley (1939). The birds were anesthetized with nembutal and the feathers plucked from the ventral aspect of the neck. An incision about one and one-half inches long was made starting between the mandibles and running posteriorly along the ventral feather tract. With small hooks the trachea and esophagus were retracted to the left and right, respectively. In this way the muscles and blood vessels lying ventral to the floor of the skull were exposed. The branching of the common carotid provided a good land mark and just anterior to this, posterior to the anastomosis of the jugular veins, the thin flattened muscles were separated with forceps and cotton swabs (a small amount of cotton rolled on a toothpick). The basisphenoid was in this way exposed and by working the connective tissue aside anteriorly the parasphenoid was also exposed. Using a dental drill with a small burr, the parts of the basisphenoid and parasphenoid lying ventral to the sella turcica was removed. Drilling was started in the midline at the suture between these two bones and the hole enlarged to about 3 by 5 mm. The thin bony capsule of the sella turcica was picked away with a sharp dissecting needle and the membranes surrounding the pituitary broken. At this time if bleeding occurred, the blood was removed with a suction cannula. No attempts were made to fill the empty sella turnica with bone wax or fibrin foam. If the bleeding was not too great, the retractors were removed, the hormone pellet placed next to the esophagus, and the incision closed.

Autopsy and Histological Technique. At the end of each experiment the birds were sacrificed and pieces of the abdominal skin were fixed in Bouin's, formal-sublimate, or 10 per cent formalin. The testes and ovaries were examined and measurements taken. All the birds were captured in the winter and the gonads were small and inactive. No significant increase or decrease in size of gonads was noted at the end of the experiments.

The pieces of skin were dehydrated in dioxane, embedded in paraffin, and sectioned at 3 to 10 microns. The sections were stained with Mallory's stain or Delafield's hematoxylin and eosin.

EXPERIMENTS

1. *Effect of Prolactin.*—Starting December 20, 1948, a pilot experiment was made to test the assumption that prolactin alone could produce an incubation patch in nonbreeding birds. Eight White-crowned Sparrows were injected daily with prolactin for six days and then sacrificed on the seventh. No controls were used. The birds were examined daily for changes in the feather distribution or vascularity of the ventral surface.

Two birds died before the injections were completed. Three adult males, two adult females, and one immature female were alive at the end of the experiment. No loss of feathers or increase in vascularity of the incubation patch area occurred. These results indicated that prolactin alone will not stimulate the development of an incubation patch.

2. *Effect of Estradiol.*—On November 23, 1950, an experiment was started to test the effects of an estrogenic substance. Estradiol pellets were implanted in three adult female and three adult male House Finches. They were placed in one of the larger cages and examined daily.

By the fifth day the blood vessels of the abdominal skin had increased sufficiently in size to be detectable with the naked eye. On the sixth day the feathers on the ventral apterium began to be shed and two days later the apterium was completely bare. This molt started at the midline in the breast and spread laterally as it does in the develop-

ment of the patch in nesting birds. By the ninth day, at which time the birds were killed, it would have been impossible to distinguish the artificially produced patch now present from that of a breeding female.

Microscopic studies of sections through the skin of the incubation patch region showed a considerable thickening of the skin due to dermal edema. In the dermis there was also a network of smaller blood vessels such as is found in an incubating bird.

Both males and females showed this response to continuous treatment with estradiol. In House Finches only the female incubates and has a patch; therefore, lack of estrogen in the male is probably the reason for the absence of the patch in males of this species.

3. *Effect of Testosterone and Estradiol.*—To test the possibility that both androgens and estrogens could produce an incubation patch, 13 Oregon Juncos were trapped and confined in one of the large cages. On December 11, 1950, testosterone pellets were implanted in seven of the birds and estradiol pellets in six. On the next day five more juncos were trapped and added as controls.

The juncos did not survive as well in captivity as the House Finches and White-crowned Sparrows. Several died in the first few days and by December 24, 1950, only 11 of the original 18 were alive. At this time the birds were examined and the incubation patch region of all the birds treated with estrogen was found to be vascular and beginning to defeather. The controls and androgen-treated birds were not changed. On January 6, 1951, the birds were sacrificed. The three estrogen treated birds remaining were all females. The ventral apterium of these was completely defeathered and the skin was vascular and edematous. Of the four remaining androgenized birds two were females and two were males. No indication of defeatherization or vascularization of the abdominal region was observable. This was also true for the controls, three of which were females and one a male.

Further evidence was thus gained that continuous treatment with estrogen will stimulate incubation patch development and that, at least in Oregon Juncos, androgens will not.

4. *Effect of Estradiol and Prolactin.*—Although satisfactory evidence had been obtained that estradiol could produce an incubation patch, there still remained the possibility that estradiol was stimulating the pituitary to secrete some hormone which was actually responsible for all or part of the response. After a technique had been perfected for the removal of the pituitary an experiment was started using hypophysectomized as well as intact (non-hypophysectomized) birds. White-crowned Sparrows were chosen for the experiment since they were best suited for the surgical procedures. Trapping was started on January 3, 1951, and the birds were confined indoors in the small cages. Since it was impossible to accumulate a large number of hypophysectomized birds due to a high mortality, the experiment was spread over a period of several weeks. The results of this experiment are shown in figure 4. Although this experiment was designed to test the effect of estrogen and prolactin on hypophysectomized birds, several other groups of birds were treated at this time with testosterone and prolactin to substantiate further the earlier experiments.

Non-hypophysectomized—Estrogen and Prolactin Treated. Starting January 23, 1951, four birds were treated with estradiol. By the seventh or eighth day the incubation patch area had become vascular and by the fifteenth day all down feathers on the ventral apterium had been lost and the skin was edematous as well as vascular. On January 26, four more birds were treated with estradiol and on the eighth day, after the apterium was vascular, two were injected daily with prolactin and two with albumin. The birds given prolactin lost the down feathers sooner than those that were injected with albumin. The birds receiving prolactin also became edematous sooner. This experi-

ment indicated that the vascular response and the defeatherization-edema response are probably initiated by separate hormones. It also suggests that the hormone responsible for the defeatherization and edema is probably prolactin.

Hypophysectomized—Estrogen and Prolactin Treated. Twenty-one birds were successfully hypophysectomized between January 4, 1951, and February 8, 1951, and were treated with estradiol pellets. A number of these died within a few days and only nine lived long enough to yield significant results. In all these the abdominal skin became vascular within six to 11 days (average seven days). One was killed on the ninth day and a cross section through the skin is shown in figure 3*g*. None of the hypophysectomized birds showed any defeatherization or edema as long as they received only estradiol,

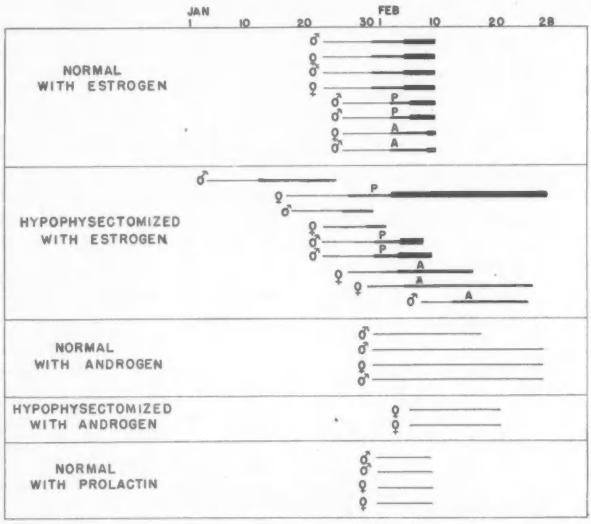

Fig. 4. Results of experiment 4. Narrow lines indicate normal condition of skin in non-breeding birds; medium lines indicate vascularity; heavy lines indicate vascularity, edema, and defeatherization. The dates on which daily administration of prolactin and albumin was started are indicated by the letters P and A. Androgen and estrogen were administered as pellets implanted at the time indicated by the beginning of the lines.

but when prolactin was given to three of the birds after they had become vascular, defeatherization and edema appeared within three or four days. Microscopic sections show that the skin (fig. 3*h*) is almost identical to that of an incubating female although not as thick. Three of the birds were treated daily with albumin, after they had become vascular, until they died, seven, nine, and 18 days later, respectively. One bird remained on estrogen alone. Both of these latter groups continued to be vascular but in neither did the apterium show the defeatherization response.

Non-hypophysectomized—Androgen Treated. Four birds treated with testosterone pellets for 20 to 31 days showed no increased vascularity or loss of feathers of the incubation patch region.

Hypophysectomized—Androgen Treated. Four hypophysectomized birds were

treated with testosterone pellets starting February 5, 1951. Only two of the birds, both females, survived for more than a few days. No change was found in these by the sixteenth day at which time they were sacrificed.

Non-hypophysectomized—Prolactin Treated. Four birds were injected daily with prolactin starting February 1, 1951. The injections were continued for 10 days but no changes were noted by this time and the birds were sacrificed.

To summarize, estradiol, which can stimulate the production of a complete incubation patch in intact (non-hypophysectomized) birds, produces only the vascularity response in hypophysectomized birds. When prolactin is given to hypophysectomized estrogen-treated birds, a complete patch develops. Prolactin has no effect when given alone. Testosterone has no effect on hypophysectomized or intact birds. One can conclude that the incubation patch is formed by the synergistic action of estrogen and prolactin. This response can be induced in both males and females, although only the females normally incubate and have a patch.

PROLACTIN CONTENT OF INCUBATING AND NON-INCUBATING CALIFORNIA GULLS

Initially, assays of the prolactin content of the pituitary were made on small birds in the hope that they could be made on the same passerine species used in the experimental and nesting studies. It was soon discovered, however, that in small passerines as many as fifteen pituitaries from incubating birds were needed to detect the presence

Table 1

Assay of Prolactin in Adult California Gulls

Date	Locality	Pituitaries implanted	Reaction*
April 14	Oakland	1 Male	—
April 21	Oakland	1 Male, 1 Female	—
		2 Male, 2 Female	—
		3 Male, 3 Female	*
May 31	Mono Lake	1 Male	*
		1 Female	*
		1 Male, 1 Female	**
		2 Male, 2 Female	****
November 3	Oakland	1 Female	—
		1 Male, 1 Female	—
		2 Male, 2 Female	—

* Minus sign indicates no proliferation, one asterisk a minimal reaction, and four asterisks a strong reaction.

of prolactin by the pigeon crop-sac assay method. Reliable quantitative results seemed improbable with such large numbers. California Gulls (*Larus californicus*) were eventually chosen for the assays when it was found that a single pituitary from an incubating bird would give a response. That the gulls are quite far removed, phylogenetically, from the fringillids used for the greater part of this study is recognized. Data from the gulls are admitted as a necessity but also on the supposition that the incubation patch among all birds is homologous and that the regulating mechanism is very similar in different groups.

The California Gulls used for the assays were collected at Oakland, Alameda County, California, and at Mono Lake, Mono County, California. The heads were removed within an hour after the birds were shot and were frozen in dry ice or a refrigerator tray. The pituitaries were removed and implanted, one to six together, subcutaneously over the crop sac of eight-week old White King pigeons. In several of the assays pieces of liver, testes, breast muscle, and spleen were implanted as controls. The pigeons were killed on the fifth day. The crop glands were removed and examined for proliferation

of the epithelium and then were fixed in 10 per cent formalin, sectioned, and stained with Mallory's stain.

The results of the assays are shown in table 1. The gulls collected at Mono Lake were incubating and had incubation patches. Those collected at Oakland, although adult, were not in breeding condition and did not have incubation patches. The prolactin content of the pituitaries of the incubating birds was greater than that of the non-incubating birds. No differences in the prolactin content of males and females were found, which correlates with the fact that both sexes of the California Gull incubate and have incubation patches.

DISCUSSION

From the results of the foregoing experiments it appears that the incubation patch, at least in frigillids, develops in response to the synergistic action of estrogen and prolactin. The incubation patches produced by these two hormones are similar to those normally occurring in these birds in the breeding season. Estrogen is capable of exerting its influence alone. It results in increased vascularity of the dermis. Prolactin, however, requires the presence of estrogen before it is able to initiate its effect, which is, the loss of feathers and dermal edema.

Studies of the reproductive cycle of many birds show that the gonads increase in size as nesting time approaches. The oviducts become larger and singing and posturing occur more often at this time. These latter responses are probably initiated by the sex hormones. While evidence is lacking for the species studies, it is almost certain that the estrogen titers are highest at the time when the changes in the incubation patch that are attributed to this hormone occur.

The evidence for the presence of prolactin at the appropriate time is even better established than that for estrogen. Prolactin assays of California Gulls show more prolactin in the pituitary during incubation than at other times in the year. Burrows and Byerly (1936) found more prolactin in the pituitary of broody races of hens than in non-broody races. These same workers also found more prolactin in broody hens than in laying hens or males (Byerly and Burrows, 1936).

The development, following estrogen treatment, of a complete incubation patch in normal birds and not in hypophysectomized ones leads to the assumption that estrogen stimulates the production of prolactin in the bird's own pituitary. That estrogen has this effect on mammalian pituitaries has been well established (Reece and Turner, 1936). Nevertheless, Meites and Turner (1947) have shown that estrogen seems to have no effect on the prolactin content of pigeon pituitaries. Riddle (1935) has suggested that the elaboration of prolactin may occur as the results of psychic stimulation, and it is possible that estrogen brings about environmental or internal relationships in the White-crowned Sparrow that initiate the necessary psychic stimulations. In any case, it seems that the estrogen does result in increased prolactin production or release through some mechanism, either directly or indirectly.

Androgens probably play no role in incubation patch formation in passerine birds. Androgen treatment did not result in vascularity in the birds tested as did estrogen treatment. This is to be expected since no males in this order have incubation patches. In some orders of birds, however, the males do incubate and have incubation patches. Androgen may, in these cases, have the same relation to the incubation patch as does estrogen in the passeriforms.

SUMMARY

The incubation patch of passerine birds was studied in the field and laboratory. Over 125 specimens from 12 families were examined and no significant variations in structure

were observed. Passerine birds have a single large incubation patch located in, and coincident in size with, the ventral apterium.

Formation of the incubation patch of passerine birds can be divided into several stages that correlate with the stages of the nesting cycle. They are:

I. Defeatherization Stage: All the down feathers of the ventral apterium are molted several days before the first egg is laid.

II. Vascularization Stage: Immediately after defeatherization the size and number of the blood vessels in the dermis increase, the skin becomes slightly thickened due to dermal edema, the feather papillae disappear, and the epidermis undergoes rapid cell division. This stage lasts until incubation begins.

III. Edematous Stage: The patch continues to become edematous and vascular and the dermal muscles disappear. This stage lasts through incubation and the first part of brooding.

IV. Recovery Stage: The edema and vascularity subside and the epidermis returns to normal. These changes are gradual, and by the time the young are able to fly and feed themselves, the skin has returned to normal (unless another clutch is laid, whereupon the cycle is repeated). Refeatherization of the patch occurs during the fall molt.

It was found that an incubation patch can be produced in non-breeding birds by continuous treatment with estradiol. If the birds are hypophysectomized, however, estrodiol will produce only vascularity. If both estradiol and prolactin are given to hypophysectomized birds a complete patch develops. Prolactin alone or testosterone, alone or in combination with other hormones, have no effect. Assays of the prolactin content of the pituitary of California Gulls by the pigeon crop-sac method shows that gulls with incubation patches have more prolactin than those without patches.

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Museum of Vertebrate Zoology and Department of Zoology, University of California, Berkeley, California, July 30, 1951.

A NESTING OF THE DOUBLE-TOOTHED KITE IN PANAMA

By ROBERT M. LAUGHLIN

The Double-toothed Kite (*Harpagus bidentatus*), currently considered one of the true kites of the subfamily Milvinae, ranges through tropical America from southeastern Mexico to Brazil and Bolivia (Friedmann, Birds N. and M. Amer., part 11, 1950:113-114). It is a small forest hawk, about 15 inches long, with rather rounded wings and tail. The upper parts, including the sides of the head, are slaty, and the under parts are largely rufous, barred with whitish on the breast and abdomen. This barring is very conspicuous in the northern race, *fasciatus,* which occurs in Panamá. The double-toothed feature of the bill is of course not a field-mark. Despite the wide range of the species, nothing definitive seems to have been published on its nesting and little regarding its general behavior. Hence the following brief observations, made at the well-known laboratory on Barro Colorado Island, in the Panama Canal Zone, may be of interest.

On June 23, 1951, two Double-toothed Kites were noted at the south edge of a clearing in the tall and very sparsely foliaged roble tree (*Tabebuia pentaphylla*), whose crown projected above the adjacent woods, affording a good view from the laboratory. During the following days one or both birds could frequently be seen perching quietly in the bare branches of this tree, or occasionally hunting lizards in nearby trees. The kite would chase a lizard up a slanting branch, hopping after it—not flying—with wings spread to maintain balance. This method of hunting, although it looked clumsy, was apparently successful, for I often saw them holding a captured lizard. The kite also ate large green insects. In El Salvador a specimen taken by van Rossem contained remains only of reptiles and insects (Dickey and van Rossem, The Birds of El Salvador, 1938:106).

I saw nothing to support the view expressed regarding the nominate race in Colombia, that it "feeds entirely upon small birds" (Todd and Carriker, Ann. Carnegie Mus., 14, 1922:146). The roble favored by the kites was also a favorite perch for many small birds. Especially in the afternoon one could often see a kite sitting quietly on a bare branch, while not far above him honeycreepers and tanagers of various species unconcernedly perched or moved about. On one occasion when a kite was chasing a lizard in a rather low tree, a pair of seedeaters (*Sporophila aurita*) did raise a noisy protest, but these birds had young, probably nearby, that had recently left the nest.

When the kites were not perching, they quickly slipped into the concealment of the forest; hence there were few occasions to see them in a long flight. Several times they did cross the clearing with several flaps alternating with a glide, much in the manner of an *Accipiter*.

On June 28, at 9:15 a.m., I observed copulation. There appeared to be no courtship display or preliminaries. The female was sitting in the roble, she turned her head from side to side, as if looking about, and the male appeared, mounting immediately. The next day I discovered the nest. It was about 75 feet up in a tall spiny cedar (*Bombacopsis fendleri*) whose crown was adjacent to that of the roble. Unlike that tree, the nest tree was thickly foliaged. The nest was a shallow saucer of twigs, placed in a crotch where one of the main branches forked. It could be seen from the steps that climb the hillside to the laboratory, but the leafage prevented a view from above. I watched the nest most of the morning. The kite (which I assumed to be the female) was apparently completing the nest. She alternately sat down and stood up, as if shaping the nest; occasionally she picked up twigs and moved them about. She seemed wary, continually

looking around when at the nest. Between 9:42 a.m., when I first noticed her leaving the nest, and 10:56 a.m., the latest I saw her on the nest that morning, she was at the nest for periods of 3, 3, and 22 minutes and was absent for 2, 3, and 8 minutes. When she approached or left the nest she always paused quietly for about a minute on a nearby branch. During the afternoon I observed neither kite in the vicinity, but towards evening I heard their characteristic shrill notes, a *chiew-ip* and a high *cheep* or *pseep*.

On June 30, July 1, and July 2, I did not see the kite go to the nest at any time. Although I did not watch all day, it was clear that incubation was not yet in progress. On June 30 one of the kites was in the roble during the early morning. On July 1 a kite brought a lizard in its talons to the roble in the morning, but then flapped and glided into the forest with it. That afternoon, following a rain, both kites sat for a long time in the roble with wings spread, as if drying out. On July 2 both kites were seen on the roble several times eating lizards or preening.

On July 3 incubation began. By late afternoon the female was sitting on the nest and she was still there when darkness made further observation impossible. Although I had watched the kites only casually that day, both birds were seen frequently in the roble.

On July 4 I first saw a kite at 7:57 a.m., when one flew across the clearing. At 8:10 a.m. the female flew to the nest from the roble without pausing on a branch, as had been her practice while building. She remained on the nest for twenty minutes, then the male arrived in the roble with a large green insect (probably an orthopteran). The female called *chiew-ip* several times, flew to the male, took the insect from him and ate it. She remained on the same limb with the male for seven minutes, preening. At 8:43 a.m. two Swainson Toucans (*Ramphastos swainsonii*) arrived at the top of the roble. Their presence was ignored by the kite who continued preening. A minute later she flew back to the nest followed closely by the toucans. As she reached the nest one toucan stopped some ten feet away, while the other flew right to the edge of the nest. The kite spread her wings over the nest, but the toucan boldly faced her. While in actual bulk not very much larger, the toucan must have been sufficiently intimidating, for although I saw no movement made with its enormous bill, the kite, after looking about nervously for a moment, slipped off the nest and disappeared. The toucan hopped into the nest, picked up an egg—which appeared whitish speckled with brown—and swallowed it, tipping up its bill a little. The two toucans then flew to a bare limb of another tree where they yelped for at least half an hour. In his paper on *Ramphastos brevicarinatus*, Van Tyne (Univ. Mich., Mus. Zool., Misc. Publ. 19, 1929:22) mentions reports of toucans preying on nestlings.

Meanwhile, at 9:00 a.m., one of the kites, apparently the male, flew into the roble with a small lizard. For ten minutes without pause he *cheeped* (like a young chick), occasionally picking up the lizard with his bill and setting it down again. For another 15 minutes he sat quietly. Then the female appeared; the male called *chiew-ip* and tendered the lizard with his bill; the female rejected the offer and flew to the top of the tree. The male then uttered several times a note I had not previously heard, a plaintive *tsiew-ip*. The female flew off. The male waited a little and finally gulped down the lizard. Ten minutes later he left, too. At 10:00 a.m. she was again at the nest, but only for 15 minutes. Between 10:15 and 11:00 a.m. she ate three green lizards, two of them brought by the male. At 11:10 a large woodpecker (*Phloeoceastes melanoleucos*) flew into the roble. The female kite left the tree, but the male twice flew at the woodpecker, without disturbing him. The kite now returned to his own perch. A few moments later the woodpecker dropped down within four feet of the kite and began pecking away. The kite attacked again, this time chasing off the intruder. During the afternoon the male con-

tinued to show intolerance. At 1:30 p.m. some White-faced Monkeys (*Cebus capucinus*) entered a *Cecropia* tree nearby. The kite left his perch in the roble and flew at the monkeys, which dropped squealing to the lower branches and soon disappeared into the forest. The kite now crossed the clearing and perched there for an hour. Meanwhile the female once briefly appeared on the roble and ate a lizard. At 3:30 p.m. two Swainson Toucans once more entered the nest tree, followed by some smaller toucans, the Collared Aracaris (*Pteroglossus torquatus*). They did not remain long, and the larger toucans flew off. The male kite now returned to the roble and, seeing the aracaris, gave chase. One of the large toucans flew into the tree, and the kite flew off.

I was away from Barro Colorado Island for several days after July 4. On my return the nest was deserted and I did not see the kites again. However, I continued to hear their calls daily, coming from the nearby jungle, until my departure some ten days later. Their remaining in the locality suggested that they might be trying to nest again.

Summary.—An unsuccessful nesting of the Double-toothed Kite (*Harpagus bidentatus*) was recorded in June, 1951, on Barro Colorado Island, Panamá. The chief prey of the pair watched was lizards and large insects. Hunting of lizards occurs by chase on foot along a limb, with the wings spread for balancing. The male brought food to the incubating female. On the second day of incubation, a Swainson Toucan (*Ramphastos swainsonii*) came to the occupied nest, caused the female to leave, and ate one egg.

Acknowledgements.—I am deeply indebted to Eugene Eisenmann, whose constant interest and many suggestions have been indispensable to me. Thanks are also due to James Zetek, Resident Manager of the Canal Zone Biological Area at Barro Colorado Island, who has done so much to make possible for so many students an unparalleled opportunity for study of life in the tropics.

Princeton, New Jersey, September 11, 1951.

EXPERIMENTS ON THE MATING BEHAVIOR OF THE BREWER BLACKBIRD

By THOMAS R. HOWELL and GEORGE A. BARTHOLOMEW, JR.

Under favorable circumstances the social and sexual responses of unconfined and undomesticated birds can be subjected to experimental analysis. The excellent review by Tinbergen (1948) lists some outstanding papers dealing with this topic. Noble (1936) and Noble and Vogt (1935) demonstrated the importance of visual clues in the reproductive activities of wild birds, and the experiments of Lack (1943) in his intensive study of the Robin (*Erithacus rubecula*) illustrate the value of concentrating on the behavior of one well known form. The interest and importance of these and similar studies led us to select a single avian species for an investigation of mating behavior.

MATERIALS AND METHODS

For this investigation, we sought a species which would lend itself to an experimental study under natural conditions. The Brewer Blackbird (*Euphagus cyanocephalus*) was selected as it has marked sexual dimorphism in color, it has colonial nesting habits which make many individuals available in a small area, and on the campus of the University of California, Los Angeles, it is abundant and extremely tame.

We prepared stuffed specimens of both sexes in approximately life-like form; these specimens are referred to throughout this paper as dummies. For our experiments, we placed the dummies on the ground and in the open near various concentrations of blackbirds on the U.C.L.A. campus. After the birds reacted to a dummy once or twice, it had to be removed for about 20 minutes or transferred to a different group in order to obtain more responses. As these birds are thoroughly conditioned to the presence of humans, we were able to make observations at close range without causing any perceptible disturbance.

To investigate the factors which influence mating reactions, we modified the dummies by deletion and substitution of parts and by changes in posture. Cracker crumbs were scattered on the ground to attract the birds' attention to the dummies, but this inducement often proved unnecessary. Experiments were carried out from March 24, 1951, to June 2, 1951.

RESPONSES

The dummies called forth a variety of responses, as described below. Insofar as possible we have employed the terminology used by Williams (1952) in his detailed observational study of the breeding behavior of the Brewer Blackbird.

Display with or without vocalization.—This performance is described by Williams as the "ruff-out." It is very similar in both sexes, but is given more often by the male. In displaying, the bird points the bill upward, fluffs out the feathers of the breast, and spreads those of the wings and tail. The tail is also depressed so that its tip almost touches the ground. Usually a single ascending, half-whistled *squeee* is uttered at the height of the display.

Males may give a display similar to that described above while walking back and forth next to an intended mate. In this display, called by Williams "male pre-coitional," the wings are half-spread and drooped slightly so that their tips may touch the ground, and the bill is pointed slightly downward.

We found that in responses of males to dummies, the "ruff-out" and "male pre-coitional" displays merged imperceptibly. Immediately prior to copulation with a dummy, the males often gave only a momentary display which we could not distinguish

from the "ruff-out." For these reasons we shall refer to all male display given just prior to copulation simply as "display."

Male elevated-tail display.—This display resembles somewhat the begging action of a young bird. The wings quiver and droop slightly, the head is held horizontal or slightly elevated, the tail is raised to an angle of about 45 degrees, and a chattering call is given. The elevated-tail display is very similar to the "female generalized display" and the "female pre-coitional display" described by Williams (1952).

Attempted intimidation by the male.—When the male attempts intimidation he may use the "head-up" display. The feathers of the body, wings, and tail are not noticeably fluffed out or spread. The bird walks stiffly, and the head is raised so that the bill points vertically. In this posture the glossy feathers of the throat and breast are prominent, and these parts are directed toward the adversary. Often additional emphasis is provided by a slight rotation back and forth of the head. No vocalization accompanies this display.

Scolding by the female.—In scolding, the female faces the object or activity which disturbs it and chatters loudly.

Incomplete copulation by the male.—An incomplete copulation is defined here as one in which the male mounts the dummy and goes through the motions of copulation but does not deposit semen. In this definition, "incomplete" refers only to the failure to ejaculate and does not imply lack of vigor in the mating attempt.

Completed copulation by the male.—In a completed copulation semen is deposited on the dummy.

Approach with interest.—We assumed that a bird was interested in the dummy if the bird flew or walked directly toward it to within three feet or less. If no response other than the initial approach was forthcoming, the approaching bird almost always stopped before getting closer than three feet. Interested males frequently advanced toward a dummy so rapidly that they bore a comic resemblance to a person walking as fast as possible without breaking into a run.

Complete indifference.—When the birds paid no more attention to the dummy than to any other inanimate object of similar size, we considered them completely indifferent.

Avoidance.—Often the birds seemed wary of a dummy, and either would not approach it or would alter their direction to avoid it.

EXPERIMENTAL RESULTS

The first experiments were attempted on March 24, 1951, at which time a female dummy was placed near a flock of male and female blackbirds with immediate positive results. From this date through May 8, suitable dummies invariably elicited vigorous responses from the birds. After May 19, with a few exceptions which will be discussed subsequently, the dummies were treated with indifference. The experiments were terminated on June 2, 1951.

The reactions to the various dummies were tested repeatedly; for purposes of documentation, however, we shall cite from our field notes only one or two typical instances of each type of response. Each of these citations is prefaced by the date of the observation, and the form of the original notes has been altered slightly in the interest of narnative continuity.

To simulate the female pre-coitional posture, we elevated both the head and tail of a female dummy to about 45 degrees above horizontal (fig. 1).. During the height of the breeding season of the blackbirds, this dummy always evoked displays and attempted copulations by the males. Once this had been established, we attempted by selective

Fig. 1. Dummy of female Brewer Blackbird in copulatory posture.

removal of parts of the dummy to determine the minimal image necessary to induce the copulatory response of the male.

FORM

First we removed the head and neck of a female dummy and found that males copulated with it as readily as if it were intact (fig. 2).

April 7.—As soon as the dummy was placed on the ground a male flew up, alighted about four feet in front of it, walked forward with obvious interest, displayed once at its right front, and mounted. The dummy tilted forward and dislodged him. He walked to its left, mounted the tilted dummy, and a complete copulation ensued. A photomicrograph of a smear of the semen deposited on the dummy is shown in figure 3.

The responses of the males to a female dummy with head and tail elevated but with the wings removed were also the same as to an intact dummy.

May 5.—A few minutes after the wingless dummy was set out, a male approached, mounted, performed a completed copulation, dismounted, and displayed on either side at the rear of the dummy before losing interest.

A female dummy was further reduced by removing the anterior part so that only the tail, the legs, and the posterior two-thirds of the body remained. As a rule the birds were indifferent to this dummy, but males occasionally approached it with interest.

April 14.—This dummy was set up near a male, and crumbs were scattered nearby. The male approached rapidly to within about three feet, then shied away and picked at crumbs. A female flew up, alighted about two feet in front of the dummy, and seemed puzzled and wary. More crumbs were scattered. The male showed a revival of interest in the dummy. He walked toward it from behind, but shied away when he got closer than about three feet. He walked to the front of it, looked, then kept on walking.

Fig. 2. Male Brewer Blackbird copulating with headless female dummy.

Similar results were obtained with other birds, but once an abortive attempt at copulation was made.

May 8.—The dummy was set up near a pair of blackbirds feeding on a lawn, and crumbs were scattered. The male walked toward the dummy but stopped five or six feet away to get a large crumb. Then a male in flight fifty yards away headed toward the pair and the dummy. He braked himself in the air above the dummy, alighted 18 inches behind it, and in one hop mounted it lightly for an instant. Immediately, the male of the pair already present made a sudden aggressive movement toward

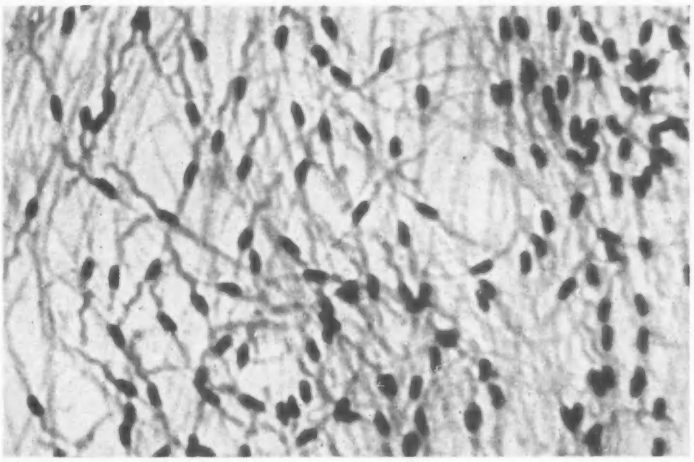

Fig. 3. Photomicrograph of smear of semen deposited on a dummy by a male blackbird, showing numerous spermatozoa; × 1150.

the new male, and the latter hopped off at once without fully attempting a copulation, but his response to the dummy was decidedly positive.

In this dummy, reduction of the anterior parts had evidently been carried to a limit beyond which no reproductive response could normally be obtained. We then began to reduce a dummy from the posterior end.

Removal of half the tail of an otherwise intact dummy did not inhibit the copulatory response of the males.

May 6.—About a minute after this dummy was set out, a pair of blackbirds which were nesting in a vine 15 feet from the dummy flew over from about 20 yards away. The female went straight to the vine, but the male alighted about three feet behind the dummy, walked to it, displayed once behind it, mounted, and twice copulated incompletely without dismounting.

When the entire tail was removed, various responses were obtained from different males.

May 6.—A pair of blackbirds flew up to the dummy. The male hovered about three feet above it, but did not alight. Then another male flew up, alighted three feet behind the dummy, watched it, but did not display. Another pair alighted near the dummy. The male was behind it and apparently interested, but he did not display. Five minutes later another male alighted about one foot from the dummy, followed by a female which alighted a moment later two or three feet in front of it. This male displayed once behind the dummy, mounted, performed an incomplete copulation, dismounted, and displayed while pacing back and forth behind it.

The dummy was then altered by removing the wings, leaving only the head, body, and legs. This greatly reduced form likewise called forth various responses.

May 8.—The dummy was set out near two pairs of blackbirds. For about five minutes they showed no interest. Then one pair flew to within 15 feet of the dummy. The male walked to within about 10 feet, looked at it, then walked toward it rapidly with apparent interest. The female, however, walked even faster, passed him, and seized a crumb about three feet from the dummy; the male veered to the side and did not approach again.

The dummy was then placed in another area. After two or three minutes two pairs came within four feet of it; the birds showed no response.

The basal half of the tail was then replaced on the dummy. In about a minute, a male alighted three feet from the dummy, walked rapidly to its front, displayed once, and mounted. The dummy fell on its side; the male continued displaying behind it but did not remount.

The half-tail was again removed and the dummy set up 25 feet away. Soon a pair came to within five feet of it, the female in the lead. The male walked within two feet of the front of the dummy, eyed it, but then flew away after the live female. A moment later a male glided up from at least 30 feet away, alighted about five feet from the dummy, walked to its front, displayed once, and mounted it. Just as he seemed to get well settled on the dummy it fell over. The copulation was not completed.

It seems evident from the mixture of positive and negative responses that the wingless, tailless dummy had been reduced posteriorly to the minimal image which would evoke a mating response.

POSTURE

Our next series of experiments consisted of altering the posture of the dummy. Since a female dummy in the normal position of the mating bird, with the tail elevated, invariably evokes a copulatory response from a male in breeding condition, we first bent the tail of a female dummy downward to about 30 degrees below horizontal. In all other respects this dummy approximated the usual mating posture of the female blackbird.

May 5.—The dummy was set out on a lawn, and three pairs of blackbirds came up immediately. A male approached the dummy from the rear and paced back and forth giving a half-display. The other birds gathered around chattering; some were picking at crumbs but all obviously noticed the dummy. Another male approached from behind, paced back and forth within 18 inches of the dummy, but did not display or mount.

The dummy was then set out nearby, with the tail now in a horizontal position, and mixed results were obtained. One male flew up and hovered over the dummy but did not alight. Ten minutes later a male glided over, alighted one foot from the dummy, displayed at its left front, mounted, dismounted, displayed on either side at the rear of the dummy, but did not remount. The copulation was incomplete. The dummy was moved away about 20 feet. Three pairs were soon attracted, and one male approached it from the side with obvious interest. As he got within two feet, another male displayed and made a short rush, driving the first one away from the dummy. Then a male approached the dummy from the rear and to one side, paced back and forth, but did not display.

The tail of the same dummy was then elevated to about 15 degrees above horizontal. As soon

as the dummy was placed on the ground, a male standing 18 feet away walked rapidly and directly to it from the right front, displayed twice on the way, displayed once beside it, and mounted. The dummy fell over, but the male displayed and mounted three times more. At least one of these copulations was completed.

These results indicate that the angle at which the tail is held is a very important postural element in stimulating a mating response. An immediate positive response is forthcoming only when the tail of the dummy is elevated above the horizontal. It is perhaps significant that in the begging posture of the juvenile, which closely resembles the copulatory position of the adult female, the tail is held approximately parallel to the ground.

COLOR

The marked color dimorphism of the Brewer Blackbird suggests that visual stimuli are important in the mating behavior of this species. The iris of the male is pale yellow whereas that of the female is dark brown. The plumage of the male is glossy black with a purple sheen, especially on the head, neck, and breast, and that of the female is dull grayish brown shading to black on the wings and tail. Composite dummies, combining both male and female parts, were used to test the significance of these color differences.

A yellow-eyed male dummy in the female copulatory posture evoked avoidance or intimidation; it never called forth a mating response from other males. Females showed wariness or indifference.

March 25.—A male dummy as described above was set out. Soon a male came to a low branch above the dummy, looked at it for about two minutes, and then descended to the ground about three feet in front of it. He walked toward the dummy, gave a "head-up" intimidation display while walking, seized a crumb, and flew off.

March 27.—The same male dummy in the same pose was set out. A female started feeding about three feet from the dummy but came no closer. A male came and fed three or four feet behind the dummy. Another male approached the dummy from the front and went into a partial "head-up" intimidation display. He continued forward slowly to within two feet of the dummy, warily grabbed a crumb, and retreated.

To investigate the importance of eye color in sexual behavior, we darkened the eyes of a male dummy with black ink. This caused no change in the response of either sex to the dummy.

April 1.—Soon after the dummy was set out, a few males and females came to within two or three feet of it but were decidedly wary. Crumbs were tossed nearby; a male flew over, started to alight, saw the dummy, altered direction, and fluttered away.

Similarly, yellow eyes did not affect the copulatory response of the males, for when we placed yellow eyes in a female dummy, males copulated with it repeatedly (fig. 4).

March 25.—A male flew up to the yellow-eyed female dummy, displayed once in front and to one side of it, mounted, attempted to copulate, dismounted, displayed again in front, and mounted again. Then another male flew up, chased the first one away, returned to the dummy, displayed, and mounted. He dismounted, displayed twice, mounted, dismounted, and displayed while walking back and forth before the dummy. For a few moments he perched crosswise on the dummy and pecked at the base of its tail. All of the copulations were incomplete.

Despite the conspicuous sex difference in eye color, the mating response of the male is evidently not inhibited by yellow eyes.

The importance of plumage color was tested next. A dummy with a female body, wings, and tail but with a male head, neck, and breast evoked a complicated pattern of response from the males.

April 11.—A dummy as described above was set out and food scattered around it. Three males and two females approached from the front, but none came closer than six feet. All looked at the dummy and seemed wary; none came up for food.

April 14.—The same dummy was set out, and for a few minutes no blackbirds were in sight. A

lone male in flight swooped down over the dummy, hovered for a moment, and flew off. Then, after five minutes, the male of a pair in flight at least 75 feet away swerved and headed for the dummy; the female followed. The male alighted directly on the back of the dummy, started to copulate, looked down and seemed suddenly disturbed, hopped into the air, and thereby knocked over the dummy. He looked at it from the side and gave it an aggressive peck on the head. His mate had meanwhile remained about six feet behind, chattering. Two other pairs flew up and hovered above the fallen dummy, chattering. Another male then flew to the dummy from behind, alighted on the ground, walked to it, and mounted. Almost as soon as he got on he hopped off to one side, looked at it, mounted, and dismounted again. Then he walked to the right front of the dummy, seemed about to display, but did not. Again he quickly mounted and dismounted, gave the start of a display, and then nervously snatched a crumb and flew to a nearby perch. None of the copulations was completed.

Fig. 4. Male Brewer Blackbird copulating with yellow-eyed female dummy.

The male portions of this dummy seemed definitely to inhibit the mating responses of the males as soon as those parts were noticed.

The reciprocal of this last dummy was made by placing a female head and neck on a male body, wings, and tail. Again a complex pattern of response was obtained.

May 5.—The male dummy with the female head and neck was set out. A male came up to it curiously but merely picked at crumbs nearby. Another male glided up from the right front, alighted, walked to the dummy, seemed about to display, but hopped back. He walked toward it a little more from the rear but again hopped away in an agitated manner. He then lost interest in the dummy and began picking at crumbs.

April 17.—The same dummy as above was set out and crumbs scattered near it. A pair of blackbirds walked toward it, but seemed wary even though its front faced them; they came no closer than three feet. Another pair flew up, hovered two feet above it, and backed off two feet before alighting and feeding. A third pair walked up to it and fed within two feet of the dummy.

In a nearby area several blackbirds were assembled, and a female was giving elevated-tail displays before two males. The male closest to her successfully intimidated the other male with a "head-up" display but made no attempt to mate with the female. Instead, he remained in his intimidation pose for about 30 seconds while she stopped displaying and walked away. Then the dummy was put down 10 feet away with its front facing these birds, and the "dominant" male immediately walked toward it with extreme rapidity. When about 18 inches from the dummy he stopped, gave a little jump upward and slightly backward, and then continued on. He displayed at the left front of the dummy and mounted; the dummy tilted forward and dislodged him. He mounted six more times. In between these attempted copulations he paced back and forth at the right of the dummy, giving continuous displays including a few of the elevated-tail type. None of the copulations was complete.

Apparently this male was in such an excited condition that his sexual impetus was enough to overcome the moment of hesitancy which almost halted him 18 inches from his intended "mate." No other birds attempted to copulate with this dummy.

SEASONAL DIFFERENCES IN RESPONSES

In view of the many immediate responses cited above, the failure of the birds to react to dummies late in the spring was striking. On May 19, for example, an intact female dummy in the copulatory position secured only negative results when placed at several localities where blackbirds were abundant. At least four males came within three or four feet of the dummy, but no closer. They showed no interest in it, and came close only to pick at crumbs. At that date most of the birds had young which were almost ready to leave or were already out of the nest. It would have been desirable to collect specimens on campus for histological examination of the gonads, but practical considerations prevented this. All reproductive responses by the birds had not ceased, however, as the following accounts show.

May 30.—An intact female dummy in the copulatory position was set down on a lawn near a group of blackbirds. A male walked up from 25 feet away with apparent curiosity, but came no closer than two or three feet and gave no displays. Then a female crouched, walked to the front and then to the back of the dummy, and gave it a sharp peck in the cloacal region. A minute later several birds of both sexes gathered, but no displays were made although the dummy was clearly a source of interest. They dispersed. Then a male walked over from about 30 feet away, displayed while walking back and forth in front of and behind the dummy, but did not attempt to mount. As he began to walk away, a female with food in her beak alighted behind the dummy and walked toward it, possibly mistaking it for a large begging juvenile. She stopped about 18 inches away, still behind it, and watched for about a minute before flying off. A male flew up from at least 40 feet away, alighted beside the dummy, displayed twice while walking back and forth beside it, and mounted. Two other males came up on either side next to the dummy but did nothing further. The male dismounted, and all the birds dispersed. About a minute later, a bird with dark eyes and female-type plumage walked to the dummy and mounted it. The dummy tilted forward, and the copulating bird pecked gently at the crown two or three times. Several birds of both sexes gathered around; the one attempting to mate dismounted and stood quietly beside the dummy for a few minutes. Then all the birds dispersed. None of the copulations was completed.

The bird just discussed might have been a female, but far more probably it was a juvenal male. Young males are not readily distinguishable from females until after the first molt.

Three days later a similar response was obtained, perhaps involving some of the same birds, as the locale was only 20 yards from that of the experiment of May 30.

June 2.—The same dummy in the same posture was set out. Two juveniles on the ground about 15 yards away were being fed by an adult male. The dummy seemed to attract attention at first, for several females and two adult males, including the one which was feeding young, approached. None, however, showed any sexual interest in the dummy, and they soon went away. About five minutes later, an adult male flew to the dummy from a tree about 30 yards away. He walked back

and forth at its right rear, displayed without vocalizing, and mounted. He dismounted, displayed again, this time with a clear *squeee* and remounted. This was repeated twice more. After mounting and dismounting a fourth time, he remained standing two feet from the dummy and seemed to rest. In another minute he flew away. A few minutes later an adult male came up from the same direction in which the previous one had gone; it may have been the same bird. He alighted about two feet from the dummy at the right rear, displayed once, but did not go closer immediately. A moment later, a bird with dark eyes, female-type plumage, and a tail shorter than that of an adult came up to the dummy also. This bird, probably a young male, stood by while the adult male mounted the dummy. The adult dismounted, and the juvenile mounted almost immediately, without displaying. Then the young one dismounted and the adult male again attempted to copulate. After the adult dismounted the young one tried to copulate twice more. Then both stood beside the dummy, panting. The copulation attempts were all incomplete. First the adult and then the young bird departed. Meanwhile, the adult male which was feeding two juveniles went on making regular trips to and from them with food, paying no attention to the mating activity going on less than 15 yards away.

The variety of responses shown by the birds described above indicates that they were in slightly different phases of their reproductive cycles. It seems likely that the young bird was a juvenal male of an early brood; possibly his behavior was an example of social facilitation as defined by Thorpe (1951).

RESPONSES OF THE FEMALE

The responses of the females to the dummies were far less marked than those of the males and typically consisted of indifference or slight fear. In one instance a female gave a "ruff-out" display within two feet of a male dummy, but since live males were in the immediate vicinity the display may have been addressed to them.

Many of the males whose activities have been described above were paired with females, and when a male responded to a female dummy, his mate often showed great agitation and scolded vigorously. As previously described, a female once actually struck a dummy, and another female approached one as if to feed it.

GROUP RESPONSES

Both males and females frequently responded as a group to the efforts of a male to copulate with a dummy. In this behavior pattern, virtually all the blackbirds within sight of the mating "pair" gathered in a group around them. The first birds to arrive started a continuous chattering which seemed to attract any others within earshot; they too flew over and joined in the vocalizing. All the onlooking birds oriented toward the "pair" and bobbed up and down slightly. Often one or more birds of either sex gave displays of either the "ruff-out" or "elevated-tail" type or both, but we never saw these lead to an actual mating. Two examples of this behavior pattern are given below.

March 25.—Two males were intent on mating with a female dummy; one intimidated the other, displayed, and mounted the inanimate female. As he was doing this, a female flew into the lower branches of a tree about 12 feet away and chattered. Within 15 seconds five females and a male flew up and alighted within a radius of 15 feet of the dummy and the first male. There were now three males and six females present. The female in the tree gave an elevated-tail display; none of the other birds gave any perceptible response to her. After dismounting, the first male stood quietly about 18 inches from the dummy, and the rest of the birds seemed very alert. Five to seven minutes later the members of the group departed one by one.

April 27.—A male was attempting to mate with a dummy consisting of a male body with a female head and neck, as described on p. 146. During the two minutes that the male was displaying and mounting, five pairs of blackbirds had gathered about, chattering. At least one male in this group gave an elevated-tail display. After the sixth copulation attempt of the mating "pair," one bird sounded two or three clear, whistled *tee-uuu*'s and the whole flock took flight in unison and alighted about 20 feet away.

The group response is not stereotyped, but it consistently involves rapid gathering, chattering, orientation toward the mating "pair," and, apparently, sexual excitement. It resembles somewhat the gathering behavior which often occurs when a bird is attacked by a predator or is otherwise in distress, but clearly differs from this in being intraspecific.

RESPONSES TO OTHER SPECIES

Only a few experiments involving interspecific reactions were attempted. For these, dummies of the male Cowbird (*Molothrus ater*), male Red-wing (*Agelaius phoeniceus*), and Hermit Thrush (*Hylocichla guttata*) were arranged as closely as possible in the mating posture of the female Brewer Blackbird and set out near a flock of the latter species. The male Red-wing was regarded with complete indifference by both sexes. The Hermit Thrush was tested in the hope that it might indicate whether or not any brownish bird in the proper pose would get a response. It, too, was treated with complete indifference by blackbirds of both sexes, but as this dummy was not used until May 12, when responses were beginning to decline, the negative results are possibly not significant.

The male Cowbird, a small icterid with a brownish head and glossy black body, provides an approximate combination of the color characters of both sexes of the Brewer Blackbird. This dummy was set out on April 7, and it received no attention whatsoever. Twice a male blackbird picked up crumbs within six inches of the dummy and gave it no apparent notice. On May 8, a slightly different response was obtained. Less than a minute after the dummy was set out, a male at least 30 feet to the rear flew up, alighted five feet behind it, and walked rapidly toward it. He looked at the dummy with apparent interest for a moment, but gave it no further attention and then walked away. It appears that stuffed specimens of these other species did not approximate closely enough the stimuli provided by a dummy of the Brewer Blackbird itself.

DISCUSSION

Our experiments indicate that the mating behavior of the Brewer Blackbird does not depend on one major factor but on combinations of such elements as form, posture, and color, any one of which is in itself insufficient to evoke a reproductive response.

In this species, as in many other strongly dimorphic birds, visual stimuli are of great importance in mating behavior. Nevertheless, although eye color and plumage color are conspicuously different in the sexes of the Brewer Blackbird, eye color does not seem to affect the sexual behavior of the male, and a few mating responses were obtained by using dummies with high proportions of male-type plumage. Although appropriate posture is necessary to elicit a mating reaction, the response does not depend on posture alone. This is not surprising since both sexes may on occasion display in a virtually identical manner. It is of interest, however, that the minimal requirements of form, posture, and color which call forth mating behavior by the male may be satisfied by a variety of combinations of these elements.

The fact that a male was already paired with a live female did not affect his readiness to respond to the dummy. This may be related to the polygamous habits of the species, which have been demonstrated by Williams (1952).

As the dummy is silent, it is clear that no vocal response from the female is necessary to evoke the mating reaction of the male. Although wing-quivering by the female may be used to attract the attention of the male (Williams, 1952), movement by the female is not necessary, for the dummy is motionless. Indeed, lack of motion seems to be an important factor in evoking copulatory responses in many birds (Tinbergen, 1948:39), and Brewer Blackbirds have been observed attempting to mate with a dead female

which had been shot from a flock (Kenneth E. Stager, Los Angeles County Museum, personal communication).

The dummy was necessarily stationary and silent, but we were able to vary a number of other factors involved in stimulating the mating response of the male blackbird.

Removal of the head of a dummy did not inhibit the mating response, nor did removal of the wings, nor even the wings and half of the tail as well. When the entire tail was removed, however, the males did not respond as readily as to a more complete dummy. When the head, wings, and anterior one-third of the body were removed but the tail left intact, only one bird reacted to the dummy in a positive manner. Apparently the dummy must have enough form to be recognized as a bird and possibly as a particular species, and must be distinguishable as regards anterior and posterior.

Although its presence is not essential to elicit reproductive behavior, the tail is probably the most important feature in mating posture. When depressed below horizontal, it is an inhibiting factor; when horizontal, it calls forth both positive and negative responses. When elevated even slightly above horizontal, however, it rapidly brings on mating behavior.

The position of the dummy becomes less important once the copulatory reaction of the male has started, for males frequently continued their mating attempts with a dummy which had tilted forward or fallen on one side.

The present evidence suggests that eye color is not significant in mating behavior; this does not mean, however, that eye color is not perceived by the birds or that it may not contribute in some way to sex or species recognition. Eye color clearly does not inhibit sexual responses by the male, but the possibility that it might have some effect on the receptivity of the female is untested.

Plumage color strongly affects the reactions of the male. The color of the head, neck, and breast appears to be of greater significance than that of the other parts. Males which mounted a dummy with a female body and male foreparts became puzzled or aggressive as soon as the distinctive glossy black color was perceived. Although it occurred only once, a sexually excited male did give a strong mating response to a dummy with a female head and neck on a male body, wings, and tail. The color of all the parts seems to be significant, but it is not surprising that the color of the foreparts, which are featured prominently in both aggressive and mating displays, should be of particular importance.

Mention should be made of the extraordinary rapidity of some of the responses of the males. At the height of breeding activity, an appropriate dummy often produced a reaction the instant it was perceived. An excellent example is the response, cited on page 146, in which a male in flight changed course at right angles 75 feet from the dummy and alighted directly on the dummy's back. A building prevented the bird from seeing the dummy until the instant before he swerved, and not more than two seconds elapsed between perception and mounting.

Another notable fact, demonstrated on many occasions, is that the reproductive behavior of the male, once it is released, may go to completion even though the sexual "partner" is entirely passive. Contact with the cloaca of the female is unnecessary, for males sometimes deposited semen on the side or flank of the dummy as well as approximately in the cloacal region. Although not necessary to bring about ejaculation by the male, active cooperation by the female must be required for fertilization.

SUMMARY

The Brewer Blackbird (*Euphagus cyanocephalus*), an abundant, sexually dimorphic form, is a favorable subject for experimental study of mating behavior as it re-

sponds readily to stuffed specimens (dummies) of its own species. To test the effects of form, posture, and color on mating responses, we modified dummies by alteration of position and by deletion and substitution of parts of both sexes.

The reactions of females to dummies are largely negative, but males respond vigorously, often mounting the dummy and depositing semen. Both sexes frequently react as a group to the efforts of a male to mate with a dummy. This group response involves rapid gathering, chattering, and orientation toward the mating "pair." Dummies of *Molothrus ater*, *Agelaius phoeniceus* and *Hylocichla guttata* evoked only passing interest or indifference.

To obtain a mating response from the male, a dummy must meet certain minimum conditions. The wings are not necessary. Either a head or a tail must be present, but one or the other may be removed without eliminating the response. Further removal of parts inhibits the mating reaction. If the tail is present, it should be at an angle above horizontal. Eye color is not important. The plumage color should be predominantly that of a female, but a female head and neck on an otherwise male-colored dummy may be effective when the male is in a state of high sexual excitement. When the dummy presents any one of the appropriate combinations of characteristics, the response of the male may be virtually instantaneous.

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REACTIONS OF POOR-WILLS TO LIGHT AND TEMPERATURE

By JOSEPH BRAUNER

Proof that the Poor-will (*Phalaenoptilus nuttallii*) hibernates (Jaeger, 1949) recently stimulated interest in this bird. Torpidity in Poor-wills has been known, however, for three-quarters of a century. Belding (1890) noted the report of a torpid Poor-will at the North American Hotel, 30 miles east of Stockton in Calaveras County, California, in January, 1879. Culbertson (1946) reported a Poor-will found in a torpid condition on February 6, 1946, in Fresno County, California. Howard L. Cogswell (personal communication) discovered a Poor-will on February 14, 1935, near a road cut under construction in the San Gabriel Mountains, Los Angeles County, California. At that time, he believed it to be injured but in light of present knowledge, he now feels that the bird was probably torpid. Herbert De Tracy of Bradley, California (personal communication), reported that he found a female Poor-will in a torpid condition in January, 1943, at the base of a tree stump. He stepped on it accidentally and killed it. De Tracy reported another torpid bird in a ploughed furrow of an open area in December or January of an unrecorded year. The bird was held in the hand for a short time after which it recovered and flew off.

The foregoing reports, together with those cited by Jaeger (1949), strongly suggest that hibernation commonly occurs in Poor-wills. If this is correct, the seasonal movements of this species should be reinterpreted. Poor-wills have been thought to migrate down into the valleys from the mountains, or south along the Colorado River, for the winter. It now appears possible that at least some populations may be sedentary throughout the year. Jaeger's hibernating bird returned to the same hole in a rock for four consecutive years.

METHODS AND MATERIALS

All the data which follow, except for the temperatures recorded from birds collected in the field, were taken from a female Poor-will which I raised. Temperature readings were cloacal and were taken with a rapid recording mercury thermometer. Light intensities were measured with a Model 603 Weston Illumination Meter which measures to 0.01 foot-candle. A constant temperature chamber was made available through the courtesy of Dr. George A. Bartholomew, Jr., at the University of California at Los Angeles.

The study area was situated on the south side of the Santa Monica Mountains north of Brentwood, Los Angeles County, California. The area is crossed by a network of fireroads and trails and is covered by chaparral consisting mostly of *Ceanothus megacarpus, Ceanothus spinosa, Rhus laurina, Rhus ovata, Adenostoma fasciculatum,* and *Salvia mellifera.*

Acknowledgements.—I am indebted to the late Dr. A. J. van Rossem for guidance throughout parts of this study and to Dr. George A. Bartholomew, Jr., particularly, for aid in the writing of this report.

REACTIONS TO LIGHT

Repeated field observations have shown clearly that the onset of Poor-will activity is indicated by calling. The time of first calls was noted and the intensity of the overhead light was measured. The photocell was placed on the ground pointed upward to take a reading of the zenith. The resulting reading was approximately the same as an average of a west plus east horizon reading. The duration of the period of the bird's activity was noted as was the phase of the moon and weather conditions.

The observations in the study area were begun on February 15, 1949, when a Poor-will was heard at 6:00 p.m. as twilight was changing to darkness. The term twilight

will be used to indicate the period between sunset and darkness. During the next two weeks, the onset of calling was noted daily and was found to occur with great regularity. The time of first call did not vary between two consecutive days by more than three minutes but the mean time became progressively later. During these two weeks, the weather was relatively uniform. On a clear sunny day, I could predict within one to two minutes when the Poor-wills would begin to call.

As the season advanced, greater variations in the onset of calling developed. On overcast days, the calling began earlier, and on brighter days, later. First, one bird would utter one, two, or three notes with short intervals between, followed within 30 seconds

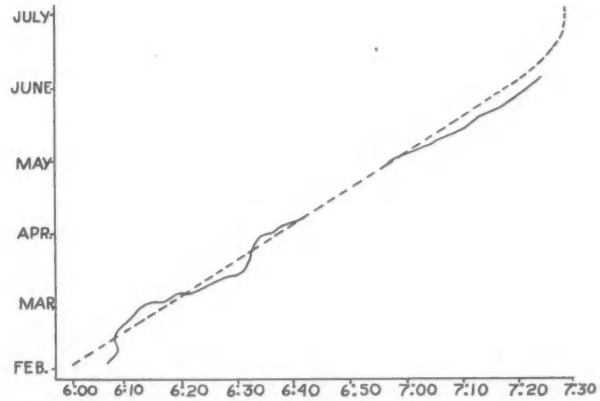

Fig. 1. Onset of activity of Poor-wills in relation to sunset. Broken line represents sunset time plus 20 minutes; solid line, activity. Gap in solid line is period when no observations were made.

by a regular cadence. Thirty seconds to two minutes later, other birds would start to call and the frequency of calls would become maximal almost immediately. Within 30 to 60 seconds of the onset of calling, birds could be seen hawking after moths.

Curves drawn for the time of first activity and sunset to see if there was a relationship showed considerable similarity (fig. 1). To represent the end of the twilight period, 20 minutes were added arbitrarily to the time of sunset. Minor variations caused by daily fluctuations in weather were balanced by taking a running average. Thirty-eight measurements of light intensity at the onset of evening activity were taken. Of these readings, 28 measured less than one foot-candle. Of the 10 readings over one foot-candle, six are probably special cases; four of these measurements were recorded at a nest from which the adult birds had been driven earlier in the day, the adults apparently being eager to return to their young; the other two measurements were recorded on overcast rainy days and appeared to be evoked by the calls of a California Quail.

Although there are no known instances of spontaneous activity by Poor-wills in the daytime, there are a few records of daytime calling. Dr. A. H. Miller (personal communication) reported one calling approximately six times at the Hastings Reservation, Monterey County, California, at 9:00 a.m. in May, 1947. Scott (1886:429) mentions numerous records of daylight singing in Poor-wills and cites an unusual instance of one "singing continuously from 12:00 m. until 12:20 p.m." in bright sunshine in the Cata-

lina Mountains of Arizona at 4000 feet on July 15, 1884. I have never seen an undisturbed Poor-will moving in a light intensity higher than 0.85 foot-candles.

There was relatively less opportunity to make field observations of morning activities. The light meter was available for only ten mornings. The light intensity at the cessation of calling was usually less than one foot-candle, although the range was from 0.3 to 1.9. Little importance can be attached to readings of over 1.5 foot-candles, for in most instances they were associated with disturbances of one sort or another. It appears that Poor-wills are not active through the night when undisturbed. They normally feed at dawn and dusk only when the light intensity is less than approximately one foot-candle.

DURATION OF ACTIVITY

One of the chief reasons for the difficulty in finding Poor-wills is their limited period of activity. From the preceding discussion it is apparent that the birds are active only for brief periods at dawn and dusk. All day long they sit quietly on the ground. As it darkens, they become active and their feeding period lasts half an hour or less. It is during this period of activity that Poor-wills can be called in most easily. Once they have enough food, they retreat to their roosts on hillsides and remain there until the morning activity period. They are quite reluctant to move after they have fed and rarely do so, although an individual bird may call a few times during the night. Observations on a captive Poor-will over a period of ten months showed that it would move about at the end of twilight and again just before dawn but would remain stationary the rest of the time.

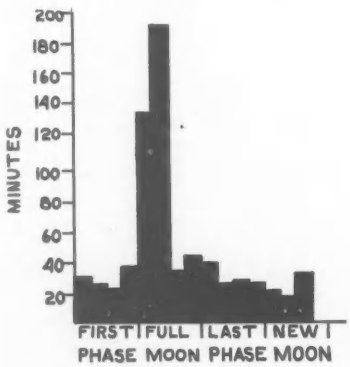

Fig. 2. Duration of activity in relation to phases of moon.

The length of the period of activity is apparently affected by weather conditions and phases of the moon. On days following or during a rainy period, the numbers of moths decreased and the period of Poor-will activity was longer. Under normal weather conditions moths were plentiful and the period of feeding was short. Birds collected from three to seventeen minutes after the beginning of activity had from 20 to 61 large beetles and noctuid moths in their stomachs. The shortest recorded period of activity was three minutes whereas the longest was 192 minutes. The mean duration for 33 observations was 32 minutes; this figure indicates the degree of efficiency of the Poor-will's feeding activities. Duration of activity was plotted in relation to phases of the moon (fig. 2). The longest periods of activity were during the full moon, but even here, there was a

well defined period of maximal activity. Even during nesting, the feeding periods were limited to the early evening and predawn hours. Since the light of the full moon at the zenith is only 0.02 foot-candles, I was unable to measure light intensities at night.

REACTION TO TEMPERATURE

The data presented are taken from field records of collected birds, nestlings, and a captive Poor-will. During the past three years, I have had an opportunity to collect a number of Poor-wills. Each one was actively flying prior to the collecting. Cloacal, ground, and air temperatures were taken immediately. The 19 cloacal temperatures range from 40.6° to 43.1°C. (table 1). There is no apparent correlation between air or ground temperature and because of the small number of temperature records, seasonal changes, if any, are not apparent.

Table 1

Temperature Data from Poor-wills Collected in the Field

Date	Time	Cloacal temperature	Ground temperature
Mar. 7, 1947	10:30 p.m.	40.6°C.	10.0°C.
Aug. 7, 1947	7:00 p.m.	41.2	30.3
Aug. 9, 1947	7:15 p.m.	42.0	.....
Aug. 17, 1947	evening	42.5	19.8
June 13, 1948	evening	42.6	15.8
June 14, 1948	evening	41.4	26.8
June 14, 1948	evening	42.4	26.8
Aug. 20, 1948	evening	40.5	.....
Feb. 20, 1949	6:15 p.m.	42.1	12.7
Mar. 8, 1949	6:18 p.m.	41.0	8.4
Mar. 24, 1949	6:40 p.m.	43.1	8.6
Mar. 24, 1949	6:42 p.m.	42.2	8.6
Aug. 17, 1949	7:10 p.m.	42.8	15.8
Aug. 17, 1949	evening	42.3	15.3
Aug. 19, 1949	7:03 p.m.	42.7	18.0
Aug. 19, 1949	evening	42.8	13.6
Feb. 17, 1950	6:05 p.m.	42.2	16.4
Feb. 21, 1950	6:25 p.m.	41.7	13.0
Mar. 11, 1950	6:22 p.m.	42.2	10.5

Daily rhythm in body temperature.—Baldwin and Kendeigh (1932) experimented on eight species of passeriform birds and corroborated the conclusions of Simpson and Galbraith (1905) that the temperature curve of diurnal birds has the maximum early in the afternoon and the minimum early in the morning. In nocturnal birds, the curve is inverted. In order to determine whether or not the Poor-will's temperature curve fitted either of these patterns, data on its rhythm for a 24-hour day were gathered.

A series of temperatures (cloacal and environmental) and light readings were taken on a captive Poor-will at three-hour intervals for a period of four and one-half days. During this time the captive bird was in an open box on a substrate of loose soil and sand. The box was placed in front of a window. Except at dawn and dusk the bird sat on the dirt or perched on the end of the box without moving except to preen or scratch occasionally. The temperature cycle of the captive Poor-will is markedly different from that of either a completely diurnal or completely nocturnal animal and resembles that of other crepuscular forms (Pearson, 1947). Two maximal and two minimal points are found during a 24-hour period (fig. 3). Maximal temperatures were found at approxi-

mately 6:00 a.m. and 6:00 p.m. Minimal readings were found at approximately 2:00 a.m. and 12:00 noon. In the majority of minimal readings, the lowest were found during the daytime. Thus to a certain degree, this fact places the Poor-will closer to the nocturnal group. Changes in body temperature were not associated with any obvious activity by the bird.

The environmental temperature fluctuated from 16.8°C. to 26.3°C., but showed no correlation with the bird's temperature. Light intensity fluctuated from 0 to 260 foot-candles, depending on the time of day.

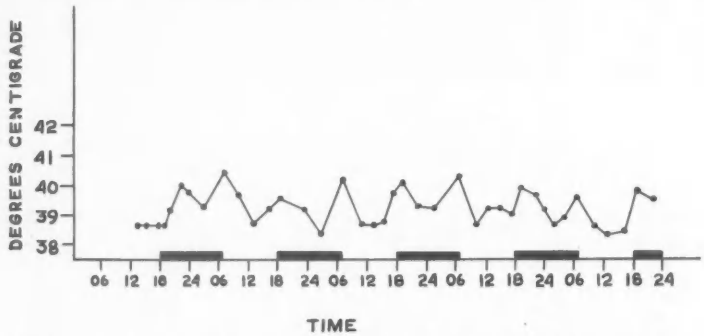

Fig. 3. Daily temperature cycle of Poor-will under room conditions. Time scale shows five 24-hour days. Black areas on abcissa indicate periods of darkness.

Exposure to cold in darkness.—The Poor-will was exposed several times in a refrigerator for from 30 to 90 minutes at temperatures of 0°C., or slightly lower. During the 30-minute exposure, the bird's temperature tended to rise sometimes as much as 0.6°C., but if the exposure were continued for from 60 to 90 minutes, the bird's temperature would fall as much as 0.7°C. from its initial level. To test the Poor-will's capacity for temperature regulation, it was kept for 12 hours (8:00 a.m. to 8:00 p.m.) in total darkness for each of 17 days at a mean temperature of —2°C. The bird's temperature was taken just before it was placed in the refrigerator and as soon as it was taken out.

In every instance the bird's temperature was lower when it was removed from the refrigerator than when it was put in. The decreases in body temperature ranged from 0.7°C. to 2.9°C. with a mean of 1.7°C. It is clearly evident that the Poor-will is capable of regulating its temperature but that its temperature varies slightly with the environment.

Exposure to cold under daylight conditions.—It was shown earlier that cloacal temperatures tended to be slightly lower during the daytime period of quiescence. This is what one might expect in a crepuscular bird. If the Poor-will were to show any tendency toward becoming torpid under cold conditions, it might be expected to best demonstrate this during the daytime when its temperature is normally the lowest.

To test this supposition, the captive Poor-will was kept during the daylight hours of March in a constant temperature chamber and subjected to a temperature of 4°±1°C. and a light intensity of 125 foot-candles. During the night, the bird was kept in the dark at room temperature (18° to 24°C.). The bird's temperature was taken approximately every three hours night and day for four days.

In every instance the bird's temperature was lower when it was removed from the refrigerator than when it was put in. The decrease in body temperature ranged from 1.0°C. to 3.1°C. with a mean of 1.7°C. As before, we see a well developed temperature

regulating ability. That the generation of body heat was in part due to muscular activity is suggested by the fact that the bird shivered frequently and strongly.

It is of interest that even when its temperature was at a minimum (36.5°C.), the bird fed with every sign of normality.

REACTION TO DAY LENGTH

Since the captive bird did not become torpid owing to low temperature, the next step was to duplicate reasonably closely the natural conditions of the period of torpidity. The latest date of Poor-will activity in the field noted by me in the Santa Monica Mountains was November 28, 1949, and the earliest resumption of activity was on January 22, 1950. Dr. Joe T. Marshall, Jr. (personal communication) noted as latest and earliest activity dates in Tucson, Arizona, December 1, 1949, and February 4, 1950. These periods coincide fairly well with Jaeger's statement (1950:109) that the period of lethargy for his bird was from November 26, 1947, to February 14, 1948.

Although the shortest time between sunrise and sunset during this period was ten hours, the effective day length for Poor-wills was twelve and one-half hours. The bird was subjected to days of nine and one-half hours duration for sixteen days at room temperature. During the daytime, it was left free in its open box in front of the window. During the period of darkness it was kept in a covered box. It was fed twice under a

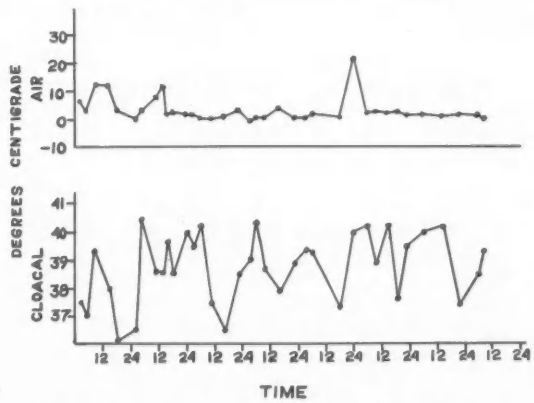

Fig. 4. Fluctuation of cloacal temperature in relation to air temperatures. Horizontal time scale in hours identical for both parts of graph.

dim red light during the dark period. The feeding never exceeded three minutes. At the end of sixteen days, the bird showed no obvious differences, behavioral or otherwise. In this instance, short days alone did not induce torpidity.

Following these artificially shortened days, the bird was confined continuously to the constant temperature chamber and was conditioned to temperatures ranging from 0°C. to 12°C. It was exposed to artificial light of 125 foot-candles for eight hours per day. After 1½ days, the temperature of the chamber was adjusted to 1°±1.5°C. for 6½ days. The lowest ground temperature in the study area taken from thermograph readings was 2.7°C. Approximately every three hours, cloacal temperatures were taken and the bird was fed. During the period that the bird was in the constant temperature chamber, its temperature fluctuated from 36.1° to 40.6°C. on a daily basis (fig. 4).

These fluctuations became progressively smaller on each succeeding day and the mean temperature of the bird actually increased during the experiment. This reaction seemed to indicate an adjustment to the environment. Even after six days, there were no behavioral changes in the bird. It fed well, flew easily and was clear-eyed and alert. The temperature cycle (fig. 4) was not the same as demonstrated earlier under room conditions (fig. 3). More than one maximal point daily is indicated but there was no regularity of occurrence.

REDUCED FOOD SUPPLY

Prior to the period of torpidity the food supply available to Poor-wills under natural conditions is limited. It is at least possible that the onset of torpidity is associated with reduced food supply. Therefore, on the seventh day of the experiment, the food supply was reduced to approximately one-third. On the eighth day, it was reduced still further. On the ninth day the bird was found dead. Dissection showed that the bird was not emaciated. On the skull were a number of blood clots indicating that it had injured itself in flying up against an upper shelf which acted as a roof for its box.

MISCELLANEOUS OBSERVATIONS

I have noted that when a Poor-will is excited or has become heated, it vibrates its white throat patch. It was observed that the bird can relax the pharyngeal muscles so as completely to expose the large and prominent blood vessels of the neck for a considerable distance down the throat. It seems highly probable that this is a mechanism by which the Poor-will may cool itself. This is apparent only in live birds when the glottis is open. I placed a Poor-will in the sun on a hot day in June, 1949, and after 14 minutes the bird's throat began to flutter, followed shortly by the opening of the mouth. The bird was in apparent discomfort and tried to move toward shade. Prior to the exposure to the sun, the bird's cloacal temperature was 40.6°C. After 14 minutes, at the onset of throat flutter, the cloacal temperature was 42.5°C. The bird was then placed in the shade for one hour at which time the cloacal temperature was 40.5°C. This experiment was repeated several times with the same result. Cowles and Dawson (1951) have reported similar reactions in nighthawks.

Table 2

Temperatures of Poor-will Chicks

Approximate age (days)	Cloacal temperature	Environmental temperature	Approximate age (days)	Cloacal temperature	Environmental temperature
3	25.1°C.	15°C.	6	33.4	18.2
3	26.7	15	7	34.5	18.8
3	20.3	12.6	7	35.3	18.8
3	21.0	12.6	11	37.3	17.8
6	33.9	18.2	12	36.2	18.2

Poor-will chicks demonstrated a poikilothermic stage like that of the House Wren as described by Baldwin and Kendeigh (1932). In June, 1949, the cloacal temperatures of young Poor-wills of the same brood were taken (table 2). It can be seen that the body temperature became progressively higher as the chicks aged except for the record of the 12-day old bird. This lower reading may have been due to the fact that the parent bird was away from the young for four and one-half hours at night prior to the reading. The environmental temperatures remained relatively constant. These measurements would seem to indicate that the temperature-controlling mechanism was still developing.

On April 9, 1950 (the earliest nesting record known), a Poor-will was found brooding two young which were approximately three days old. One hour and twenty minutes after the parent bird left, the cloacal temperatures of the nestlings were 25.1° and 26.7°C., while the environmental temperature was 15°C. Two hours and ten minutes

later when the environmental temperature was 12.6°C., the cloacal temperatures were 20.3° and 21.0°C. The correlation between body temperature and environmental temperature suggests poorly developed temperature regulation. At the time of the last reading, the chicks were shivering. Therefore, it can be said with reasonable assurance that there was some temperature-controlling mechanism in these semi-poikilothermic young.

DISCUSSION

The induction of torpidity in the Poor-will seems to involve a combination of several factors: light, temperature, food, and possible psychological influences. Further experiments with more individuals under controlled conditions will be necessary before a satisfactory explanation can be found. It seems possible that light may be a major factor in bringing about torpidity; certainly the activity of Poor-wills is closely correlated with light conditions during any twenty-four hour period.

I have not found a torpid bird despite many hours of searching areas where they have been active. During their nesting period, I have found them highly sedentary. To find an active Poor-will by flushing it when a few feet away is a major problem but to find one while it is hibernating by deliberate search has yet to be accomplished. Therefore, the possibility remains that they often stay in the same area throughout the year.

SUMMARY

The onset and cessation of Poor-will activity at dusk and dawn coincides with a light intensity usually lower than one foot-candle.

The duration of activity is limited and is apparently related in length to phases of the moon and to weather.

Cloacal temperatures of active Poor-wills range from 40.6°C. to 43.1°C.

Poor-wills can control their body temperature at low environmental temperatures.

The daily temperature curve of a Poor-will has two high and two low points differing from nocturnal and diurnal birds which show only one of each during any twenty-four hour period.

Neither exposure to cold during daylight, shortened days with and without reduced temperatures, nor reduced diet caused torpidity in a captive Poor-will.

Apparently, Poor-wills cool themselves by vibrating their throats and moving air across the large exposed blood vessels of this area.

Poor-will chicks demonstrate semi-poikilothermy.

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Los Angeles, California, November 13, 1951.

BEHAVIORAL AND EVOLUTIONARY SIGNIFICANCE OF THE ABNORMAL GROWTH OF BEAKS OF BIRDS

By WADE FOX

Although peculiarly shaped or abnormally long beaks are not uncommon among caged birds, to my knowledge very little has been reported concerning the occurrence of such abnormalities among wild birds. The bizarre growths in captive birds are generally believed to be due to injury of the tissue that produces the rhamphotheca or to some condition that causes imbalance in the wearing processes. While it seems likely that injury may also account for the few cases of beak abnormalities among wild birds that have come to my attention, there is also the possibility that some of the latter may be due to mutation.

Bowles (Condor, 10, 1908:129-130) reported an adult female Red-breasted Sapsucker (*Sphyrapicus varius*) in which the upper jaw was two and one-half inches long and curved far over to the right. He observed this bird feeding by digging with the long upper half of the beak. It had to turn its head to one side to pick up the food. Although this bird would appear to be handicapped, Bowles stated that it fed easily and was fat and healthy.

Jack von Bloeker, Jr., and I collected an adult female Scrub Jay (*Aphelocoma coerulescens*) in the piñon-juniper association on the southeastern slope of the San Jacinto Mountains. In this bird both the upper and lower portions of the bill are unusually long (fig. 1). The upper mandible measures about 66 mm. in length and the lower about 62 mm. In life both portions of the bill were slightly twisted dextrally, although the tips approximated each other fairly closely. As the prepared specimen dried, the upper mandible curved sharply to the right, considerably separating the two tips. This bird was well fed and appeared in good health. Notes on its feeding behavior were not obtained.

Dr. Loye Miller has kindly placed at my disposal two peculiar specimens in his collection at the University of California at Los Angeles and has suggested that I place on record his observations regarding one of them.

The first, an adult California Thrasher (*Toxostoma redivivum*) was collected near Westwood Village, Los Angeles County, California. The feathers were missing from the head and neck, and it was in very poor health. The specimen has an exceptionally long, down-curved bill that turns slightly to the left toward the tip (fig. 2). The upper mandible is broken off at a length of 69 mm. The unbroken lower mandible measures 112 mm. Both of these measurements were taken along the curvature of the cutting edges of the mandibles. The bird appeared to be weak and emaciated when collected. One is inclined to assume that the bird had not been able to feed adequately with the abnormally long bill. However, it is equally possible that the starvation was due to the broken upper mandible. The break was sharp and possibly postmortem.

The last specimen which I wish to report is a male Black-headed Grosbeak (*Pheucticus melanocephalus*) collected by Loye Miller on May 30, 1926, on Mount Pinos, Kern County, California. The abnormality in this case consists of a flange of rhamphotheca on the left side of the lower mandible which extends across the side of the upper mandible. It would appear that this bird could have fed only from the right side of the beak and that it must have been considerably handicapped by this deformity. Nevertheless, the bird was in good condition and was apparently well fed. More interesting than the bird itself are the following observations made by Dr. Miller at the time of collection. He had observed one grosbeak feeding another and had assumed that this was an instance of a male feeding a female in early courtship. Upon shooting the bird

that was being fed, he was surprised to find that it was the male with the abnormal bill. There was no doubt in his mind that a female had been feeding the male. It seems probable that the well fed condition of the male and his obviously recent successful migration had been made possible by the efforts of the female. At least, in view of the male's handi-

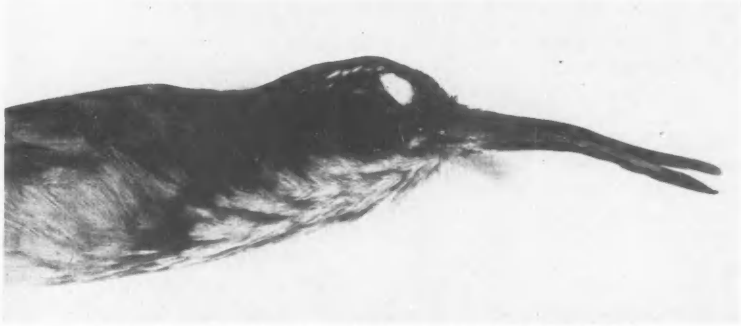

Fig. 1. Abnormal Scrub Jay from the San Jacinto Mountains, California.

capped condition and the attention shown to him by the female, the dependency of the male on the female for an extended period seems evident.

This spectacular departure from the usual behavior of Black-headed Grosbeaks suggests that there may be many more possibilities for variations of bird behavior than

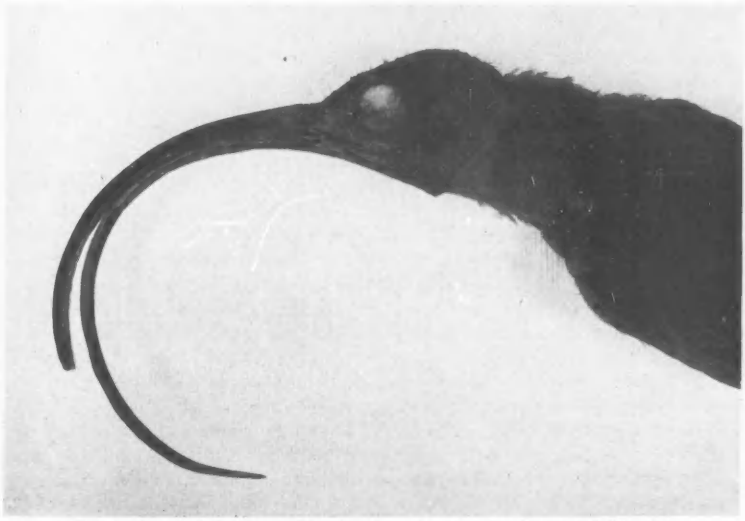

Fig. 2. Abnormal California Thrasher from Los Angeles County, California.

one might expect in view of the great emphasis placed on their stereotyped reactions. Much insight into bird behavior might be gained by studying rare abnormal individuals such as those mentioned above. Such observations give some clue as to the extent to

which set behavior patterns are adjustable to new situations. Further, they lead one to suspect that an abnormal structure may effect not only the behavior of the individual in which it occurs, but also that of other members of the species which it may encounter. I think it is important to reemphasize the value of studying these rare freaks of nature alive and in their natural habitat. Once such a specimen is collected nearly all its value is lost.

From the standpoint of evolutionary possibilities, it would be interesting if these enlarged and malformed bills could be shown to be due to variations of the germ plasm. It seems more likely, however, that as in aviary birds, they are caused by injuries to the rhamphotheca. X-ray examinations of the beaks of the three birds to which I had access revealed that the bony portions of the beaks were normal in size and shape and that the abnormal growths were confined to the dermatheca (for the X-ray photographs I am indebted to Mr. Lee Swinford of the University of Southern California Dental School). If the excessive length of the bills of the jay and thrasher was due to mutation one might expect that the bony portions of the beaks would be longer than those of normal birds; if due to injury one might expect to find scars on the bones. While the X-ray photographs were not conclusive, they lend greater support to the possibility that the growths were due to injuries since the bony structure of the bills appeared to be normal. In the case of the Scrub Jay, the eroded appearance of the dermatheca at the base of the beak lends further support to this thesis. On the other hand, the remarkably parallel growth of both the upper and lower mandibles in both the jay and thrasher suggests that the abnormality may be genetic in nature. It seems questionable that both mandibles could maintain such long, uniform and correlated growth if each portion had to be stimulated to grow by injury. While this is not impossible, it seems a very remarkable coincidence. Caged birds frequently develop unusually long bills due to lack of wear. Possibly lack of wear could account for both the excessive growth and the correlation between the two mandibles.

In itself, the occurrence of these abnormal beaks does not clearly have evolutionary significance. However, the successful survival of the individual birds possessing structures foreign to the species may have such evolutionary significance. Whether mutation or injury proves to be the cause of the abnormalities, it can not be denied that the behavior of the species in each case was sufficiently plastic to permit at least a partly successful utilization of a "new tool" for several months, possibly for more than a year.

In at least one case, the adjustable social behavior of both male and female appears to have been responsible for the survival of the malformed male; in the other cases individual adaptability of the abnormal bird seems to have been sufficient. In the face of observations such as these, one is tempted to postulate that should such a markedly different structure arise due to heritable mutations, the individual involved would have a fair chance of surviving, thus affording an opportunity for further evolution of the species. There are frequent occasions when one wonders what the chances are for the coincident occurrence of mutations resulting in the formation of a "new tool" and the simultaneous alterations of the nervous system which would render this tool useful. The survival of the abnormal birds herein described suggests that perhaps the functioning of the nervous system of the bird is more labile than we have been led to believe. Perhaps there is a very good possibility that a "new tool" could survive for several generations and thus afford an opportunity for the appearance of behavioral patterns suited to cope with a new situation.

Department of Zoology, University of Southern California, Los Angeles, California, January 10, 1952.

SOME BIRDS OF NORTHWESTERN SONORA, MEXICO

By ALLAN R. PHILLIPS and DEAN AMADON

The traveler visiting Puerto Libertad on the Sonoran coast drives through desert country all the way south from Sásabe, on the Arizona border, except in the fertile valley of the Rio Magdalena about Altar, Pitiquito, and Caborca. Off to the east, however, he sees a well wooded range, the Sierra Carrizal. The whole region is very little known. The fine survey of the bird life of Sonora by van Rossem (1945*b*) shows that few ornithologists have set foot in the large region between the Pajaritos Mountains and the Nogales-Hermosillo highway and railroad, on the east, and the Colorado delta and Punta Peñasca, on the west. Thus it seemed that a visit to the Sierra Carrizal and the Caborca area might prove interesting.

With this in mind, we made camp ten miles south-southwest of Sásabe on the grassy *Aristida*-mesquite plain on the evening of October 19, 1948. After exploring these plains and a nearby small arroyo for three days, we drove south and east 29 miles on October 23 to Rancho Carrizal, at the west end of the Sierra Carrizal nine miles southeast of Los Molinos. This ranch is some five miles west of the lowest oaks, which unfortunately proved very difficult of access. Thus we could spend but two hours, at high noon, in the oaks. Near the ranch itself, however, we found some interesting birds along the main arroyo where a number of large "chinos" (*Mimosa* sp.) grew, besides various smaller trees and shrubs. In this vicinity, too, we first encountered organ-pipe cacti. The whole country here was terribly overgrazed.

On October 27 we drove south, reaching Altar the next morning. After an afternoon's excursion through the Pitiquito farmlands, we camped in the mesquite thicket two miles east of Caborca, across the river from a steep little hill. At the base of this hill ran an irrigation ditch, bordered in spots by brush. This, the adjacent fields, and the brush along the river edges were so full of birds that we spent six days here. On November 4 we again visited Pitiquito briefly, then drove northwest, reaching Sonoyta the next afternoon. Here we spent three days, collecting mainly in the mesquite thicket two miles northeast; but the border town itself and adjacent farmlands to the west were also visited repeatedly.

We are indebted to Dr. Frank W. Gould, formerly of the University of Arizona, for certain plant identifications, and to Dr. Ira N. Gabrielson, Lyndon L. Hargrave, Gale Monson, the late Dr. Max M. Peet, and the authorities of the Carnegie Museum, the Dickey Collections of the University of California at Los Angeles, the Fish and Wildlife Service and the United States National Museum, the University of Arizona, the Museum of Vertebrate Zoology, the University of Michigan Museum of Zoology, and the University of Utah for the loan of specimens used for comparison. The specimens obtained were divided among the collections of the senior author, the American Museum of Natural History, and the Dirección General Forestal y de Caza, Mexico City. To the latter agency we are greatly indebted for scientific collecting permits.

In the following list of our more interesting findings, subspecific names are used only when specimens were secured. Wing measurements are of the chord.

Phalacrocorax auritus. Double-crested Cormorant. One was seen regularly near Caborca from October 29 to November 2, when it was obtained, furnishing the first inland record for Sonora. Unfortunately, single immature birds cannot be identified racially; the wing, which is worn, measused 311 mm.

Butorides virescens. Green Heron. An immature female seen regularly near Caborca, October 29 to November 2, is referred to *anthonyi* because of its pallor, although it is small (wing 179 mm.). A certain amount of white in the primaries suggests partial albinism. At this late date the bird was doubtless wintering.

Leucophoyx thula. Snowy Egret. A flock of ten, with other, larger herons, was seen near Caborca on October 29, but not later. No inland records are mentioned by van Rossem.

Oxyura jamaicensis. Ruddy Duck. One was seen on a represo in the desert about midway between Caborca and Sonoyta, November 4.

Mergus serrator. Red-breasted Merganser. One in female plumage seen near Sonoyta on November 7 and 8, is the first truly inland record for Sonora.

Cathartes aura. Turkey Vulture. Seen regularly, but in very small and decreasing numbers except in the Altar-Caborca regions. Even here the largest flock seen was of seven birds on the first evening. After we left Caborca, the Turkey Vulture was seen only once: on the morning of November 6 one was sunning itself in the mesquite forest near our Sonoyta camp, and later presumably the same individual was seen in flight—probably to warmer climes, for we saw it no more. At any rate, we cannot agree that the species is "common" in winter in this part of Sonora.

Polyborus cheriway. Caracara. Much scarcer in this region than on the road farther south toward Puerto Libertad as observed by Phillips in February, 1932. At least four were seen at Los Molinos, and five in the next ten miles to the south on October 27. Otherwise, we saw only a single bird, 36 miles northwest of Caborca on November 4.

Lophortyx gambelii. Gambel Quail. Birds from Caborca are more richly colored (browner dorsally) than ones from near Sasabe. Like those from near Tecoripa (Univ. Ariz. Coll.), they are intermediate toward *fulvipectus*. Farther east, such intergrades have been taken north to about 37 miles south of Nogales (Pitelka, 1948); Caborca is probably near their northwestern limit. A female from 21 miles south of Sonoyta is very pale and gray, in fact more so than *pembertoni* of Tiburón Island, which we regard as a synonym of *gambelii*.

Actitis macularia. Spotted Sandpiper. In view of the absence of previous Sonora records for October and November, it may be noted that we saw one daily near Caborca, October 30 to November 3.

Chlidonias nigra. Black Tern. A lone bird was collected on the Rio Magdalena, October 31. Not only is this the first record from a point definitely within Sonora, but the date is exceptionally late. The specimen proved to be a somewhat emaciated immature female weighing 42.4 grams.

Columba fasciata. Band-tailed Pigeon. One was flushed from a mesquite on the plain ten miles south-southwest of Sasabe on October 21. Its occurrence in such a locality must be very rare. Previous Sonora records are all from Nogales eastward.

Zenaida asiatica. White-winged Dove. Not a single individual was noted by us at any time. This is noteworthy in view of the report (Neff, 1947) of an exceptionally large nesting colony in the very area, near Caborca, that we worked most intensively.

Cynanthus latirostris. Broad-billed Hummingbird. A single female, the only one seen, was taken near Caborca on October 31. This is the farthest northwest that the species has been taken in winter, and in fact the westernmost point of record at any season.

Calypte anna. Anna Hummingbird. This species and *C. costae* were about equally common in November and the last of October. The latter was perhaps the more numerous near Caborca, especially about the clumps of flowering *Lycium Berlandieri* within the mesquite thicket; but it seemed to be outnumbered by *anna* farther north, although a male was taken 21 miles south of Sonoyta. Of *anna*, two young males and a female were taken near Caborca, October 31 to November 3, and one at Quitovac, half-way from Caborca to Sonoyta, November 5. One was seen at Sonoyta the same day, and one or two others later. These records extend the autumn range slightly to the south (see van Rossem, 1945*a*; Phillips, 1947).

Selasphorus rufus. Rufous Hummingbird. A female was taken and a young male seen, October 31, near Caborca, and one was seen the next day. At these dates they may have been wintering.

Chloroceryle americana. Green Kingfisher. A few were seen and two were taken near Caborca, along steep-banked ditches and at the river. This may possibly represent a range extension or a winter dispersal, since the birds have never been found here previously.

Asyndesmus lewis. Lewis Woodpecker. Several were seen, and an immature female was taken, at Rancho Carrizal, where they occurred from the ranch up into the oaks. This was apparently the

most southwesterly point reached in the 1948 flight. One was seen flying over on October 21, ten miles south-southwest of Sasabe, and there was one at Sonoyta on November 5. Prior to 1948, only a single specimen had been recorded in Sonora.

Pyrocephalus rubinus. Vermilion Flycatcher. Seen only at Pitiquito and Sonoyta in farmlands, verifying van Rossem's surmise of a considerable recession from this region in winter.

Tyrannus vociferans. Cassin Kingbird. One was seen and heard calling near Pitiquito on the evening of October 28. Its status so far west is probably that of a rare transient.

Tyrannus verticalis. Western Kingbird. An adult male was taken near Pitiquito on the evening of October 28. It was fat and would doubtless have departed shortly thereafter. The date is quite late, perhaps unusually so.

Empidonax hammondii. Hammond Flycatcher. Several *Empidonax* flycatchers that were clearly not *griseus* were seen at Rancho Carrizal. Specimens of *hammondii* were taken both near the ranch (October 23) and in the oaks (October 24). Since the species winters locally in southern Arizona (Monson and Phillips, 1941), it may possibly do so here; if not, the number seen on such late dates is surprising.

Empidonax griseus. Gray Flycatcher. Seen only at Rancho Carrizal and in the mesquite thicket near Sonoyta; none taken. Evidently not common in winter in this part of Sonora, from which it has not been recorded previously.

Camptostoma imberbe. Beardless Flycatcher. Specimens taken at and above Rancho Carrizal, along the canyons, extend the range of this obscure bird to the northwest. Presumably it winters here, as it does in parts of Arizona. Our two males lack the dusky crowns supposed by some authors to mark *C. imberbe,* but so do some other juvenal and winter specimens (to late March) from Arizona. This appears to be partly seasonal and partly individual variation.

Eremophila alpestris. Horned Lark. Seen as far south as the bare playa a bit north of Altar. Here, from a hundred or more birds, we obtained a male *leucolaema* and a female *occidentalis.* A third specimen is peculiarly varied with grayish and richly colored areas; it cannot be placed satisfactorily. These are the southernmost records of any Horned Lark in Sonora. South of Sasabe we obtained only the resident race *adusta.*

Hirundo rustica. Barn Swallow. Two or more were seen, flying south, south of Sasabe on October 20. One seen on the river in the mesquite thicket near Sonoyta, November 8, was exceptionally late, if it was not wintering there.

Tachycineta thalassina. Violet-green Swallow. Swallows, mostly of this species, were migrating south commonly on October 20 near Sasabe, but the flight ended very abruptly. About forty *Tachycineta* were seen on October 20, plus five or so other swallows; but on October 21 only one flock of two or three *Tachycineta* was noted, and thereafter not a single swallow except for the above-mentioned *Hirundo.*

Corvus corax. Common Raven. An adult male taken by Amadon west of Caborca, November 4, is good *sinuatus,* measuring: wing, 438; tail, 237; culmen, 75; bill depth, 24; depth of tarsus, 10.5 mm.; weight, 1067 gms. (see Willett, 1941). Being one of a pair, it may represent the breeding population there. Its molt was not yet completed.

Parus wollweberi. Bridled Titmouse. Four specimens from the oaks of the Sierra Carrizal show a slight departure from *phillipsi* in their rather slender bills. The type locality of the latter is in the very next range, the Pajaritos Mountains, but of course these two ranges are separated by Lower Sonoran Zone in the valleys in which no *Parus* breeds.

Thryomanes bewickii. Bewick Wren. A pale *eremophilus* was taken at Rancho Carrizal, and a very few single birds were seen near Caborca and Sonoyta. Presumably it is merely a winter visitant at the latter two localities. Van Rossem lists no records for this part of Sonora.

Toxostoma bendirei. Bendire Thrasher. One seen near Pitiquito, November 4, was the only one definitely identified on our trip. This is the westernmost record in Sonora.

Toxostoma curvirostre. Curve-billed Thrasher. All our specimens represent the race *palmeri,* with the possible exception of two from the Pitiquito-Caborca area, which have the crissum darker; this is presumably an approach to *maculatum.* The two birds from Rancho Carrizal are also atypical, showing some approach to "*celsum.*"

Toxostoma dorsale. Crissal Thrasher. Two adult females from Sonoyta are referable to the nominate race, although one is atypical. This is probably near the western limit of this race. One from

45 miles northwest of Caborca is browner (less gray) than most fresh-plumaged birds, and thus hardly comparable. In pallor it seems nearest *T. d. coloradense* van Rossem (1946), to which must be referred a fourth adult female from Rancho Carrizal. This last, taken October 26, is perhaps a vagrant.

Hylocichla guttata. Hermit Thrush. As in most of southern Arizona, *H. g. guttata* proved to be the most numerous wintering Hermit Thrush in northwestern Sonora. It was taken at Rancho Carrizal (October 26) and near Caborca (November 3) and at Sonoyta (three, November 7-8). Some of these specimens show a slight approach to "*nanus,*" whereas another, a young male taken near Sonoyta on November 8, is properly referable to that race, which is thus added to the Sonora list.

Two October migrants are interesting. A very young male from the oaks of the Sierra Carrizal, October 24, is an extremely gray and pale bird, even grayer than available *slevini,* but rather large (wing 91.5 mm.). An adult male from south of Sasabe, October 20, is intermediate between *slevini* and *guttata,* and thus represents the race of the Cascade Mountains and of the Rainbow Mountains, southwestern British Columbia, to which we apply tentatively the name *oromela.*

Hylocichla ustulata. Swainson Thrush. An immature female taken in a small wash near a ridge-top just below the lowest oaks of the Sierra Carrizal, October 24, is of the northwestern race *H. u. ustulata* (not *oedica*). An equally reddish-looking bird was flushed later that day among the oaks (Phillips). These records are particularly interesting because of the great scarcity of the species in autumn anywhere between the Pacific slope of California (and northwestern Baja California) and its winter home. October 24 is near the end of the fall migration. Can these birds have been lingering from the main flight that perhaps follows the unexplored mountain tops just inland from the Gulf of California? Farther east and north the species is hardly more than a straggler in fall, although common in spring. The race *oedica* is even scarcer in fall, if indeed it occurs then at all.

Anthus spragueii. Sprague Pipit. This species is supposed to winter only in the region east and south of the Pecos River. It is unrecorded from New Mexico and trans-Pecos Texas and has long been considered merely casual in Arizona. It was therefore a great surprise to find it on the plains ten miles south-southwest of Sasabe, some 1000 miles farther west. We obtained three specimens, all immatures, and saw at least one other. Since they were always seen singly, we could not tell how many were present, but the species was frequently encountered. Our first specimen, a male (October 21), is of a rather unusual appearance, being quite black-and-straw-yellowish rather than the usual, less contrasting, brown-and-buff. It also has a rather short hind claw. A similar black-and-white juvenile is from the Souris River, which runs from North Dakota into Manitoba, August 9 (Amer. Mus.).

Bombycilla cedrorum. Cedar Waxwing. Our brief trip was ample to substantiate van Rossem's contention that previous lack of fall records (and of any record for northwestern Sonora) was due simply to lack of observation. We encountered these waxwings at and above Rancho Carrizal, in the plaza at Caborca and at our camp to the east, and at and around Sonoyta. Indeed, wherever we found tall trees, we found waxwings.

Vireo huttoni. Hutton Vireo. A lone adult taken in the oaks of the Sierra Carrizal extends at least the winter range slightly to the westward.

Vireo solitarius cassinii. Solitary Vireo. Since these vireos are now known to winter in small numbers in central southern Arizona, it was not surprising to find two in the mesquite thicket near Sonoyta on November 6. An adult female was taken. We were surprised not to see any others in the course of our entire trip.

Vermivora celata. Orange-crowned Warbler. These warblers were annoyingly common near Caborca, although they always occurred singly. Our single specimen, like most if not all the birds seen, represents the Rocky Mountain race, *orestera,* for which fall records were lacking heretofore—a striking commentary on our meager knowledge of Sonora birds. We neither detected nor suspected the presence, at this season, of *lutescens,* which van Rossem considers "by far the commonest" race in Sonora.

Dendroica nigrescens. Black-throated Gray Warbler. Since this warbler is now known to winter in southern Arizona, it may be expected to do so in most parts of Sonora. But we were surprised to find it the commonest warbler in the Sierra Carrizal, outnumbering even *D. auduboni,* which, however, was scarcer than we had expected. Some eleven individuals were seen there, and one was taken in the oaks. A female was seen near Caborca daily through October 31, but not thereafter.

Oporornis tolmiei. MacGillivray Warbler. Two females were taken near Caborca, an immature on October 29 and an adult on November 1. The former represents the nominate race. The latter,

which was first seen on October 31, represents the proposed race *intermedia*. The birds were probably still on migration, although the dates are very late.

Geothlypis trichas. Yellow-throat. Several were seen near Caborca. Two young males taken represent the races *arizela* and *occidentalis*.

Icteria virens. Yellow-breasted Chat. A young male was discovered in dense, low thickets in the mesquite forest near Caborca, November 1, and was obtained the next day. A number of secondaries in the left wing were in sheaths, their tips barely projecting. The total length of these feathers is 15.5 mm. The bird was not fat, however (weight 23.1 grams), and it is therefore doubtful that it would have migrated farther south in any case. In its small size (wing 74, tail 75 mm.) and dark color, it seems to approach the race *tropicalis*.

Wilsonia pusilla. Pileolated Warbler. A young male taken near Caborca, October 30, was not fat; it represents the race *chryseola*, which is known to winter in southern Sonora.

Tangavius aeneus. Red-eyed Cowbird. Seen only at Pitiquito, where a few were presumably wintering.

Sturnella magna. Eastern Meadowlark. Three specimens (*S. m. lilianae*) taken ten miles south-southwest of Sasabe substantiate its occurrence this far west in Sonora.

Piranga ludoviciana. Western Tanager. An adult male taken near Caborca on October 30 was quite fat and possibly was a belated transient.

Pyrrhuloxia sinuata. Pyrrhuloxia. Less common than the Cardinal in this part of Sonora. Found at Rancho Carrizal, and a male and a female were seen by Amadon near Caborca; but in the Sonoyta region only Cardinals were encountered.

Guiraca caerulea salicaria. Blue Grosbeak. Two were taken from a flock of three or more in a grassy, weedy cotton-field near Caborca, November 3, at which date they were presumably wintering.

Passerina amoena. Lazuli Bunting. Occasionally heard in the Pitiquito-Caborca region; a male was well seen on November 2. Since it is now known to winter, at least occasionally, in central southern Arizona, similar occurrences in northern Sonora may be expected.

Spinus pinus. Pine Siskin. A very few were seen near Sasabe, Caborca, and Sonoyta, and in the oaks of the Sierra Carrizal, but none was taken. These records appear to be the southernmost for the coastal plain.

Spinus tristis. American Goldfinch. A single bird was heard flying over the mesquite thicket near Sonoyta on November 6, giving its characteristic call. It could not be secured. There are no previous Sonora records.

Pipilo maculatus. Spotted Towhee. Not at all common; single birds were seen well at Rancho Carrizal, near Caborca, and in the mesquite thicket near Sonoyta. Special efforts netted only a single specimen, an adult female from Rancho Carrizal, October 27, which is of the race *montanus*. These are the southernmost Sonora records; all the birds were, of course, winter visitants.

Ammodramus bairdii. Baird Sparrow. Occurrence on the Sonora side of the border near Sasabe is substantiated by an adult male taken ten miles south-southwest, October 23. This was the only one seen. In former years the species was doubtless common, although but two or three others have been taken in Sonora, and these along the border in the extreme northeast (Animas Valley, 1892, by Mearns).

Amphispiza bilineata. Black-throated Sparrow. A young male taken near Sasabe, October 20, is quite gray like *confinis*, more so than are birds of the Ajo Mountains. The systematic status of birds of this border region is unsettled; see Phillips and Pulich, 1948.

Junco hyemalis. Slate-colored Junco. A young male taken in the mesquite thicket near Sonoyta on November 6 adds the race *hyemalis* to the Sonora list, although its pale gray sides contrast slightly with the head.

Junco oreganus. Oregon Junco. Juncos of the *montanus* type were seen near Caborca and south of and near Sonoyta. At least four juncos were seen at the former locality, all or nearly all of which seemed just like the two taken on November 1, which are of the large interior race *J. o. montanus*. There is only one previous published record of this race in Sonora (Peet, 1946), but it is probably common. An occasional *J. o. mearnsi* was seen by Phillips in the oaks of the Sierra Carrizal and in the mesquite thicket near Sonoyta, but none was positively identified elsewhere.

Junco caniceps. Gray-headed Junco. Seen only at and above Rancho Carrizal; a specimen was

taken in the oaks, October 24. All were of the race *caniceps* save a characteristic hybrid between *mearnsi* and *caniceps* seen at the ranch, October 24.

Spizella atrogularis. Black-chinned Sparrow. Two were seen (one taken) near and below the lowest oaks, on a ridge and in a canyon of the Sierra Carrizal, October 24. It is doubtless a winter resident here. The species previously was known in Sonora only from a single specimen taken in June in the Sierra de Oposura (Cahoon).

Zonotrichia coronata. Golden-crowned Sparrow. A single bird in "immature" plumage was seen by Phillips in a large flock of *gambeli* near Caborca on November 2. He could not secure it.

Melospiza georgiana. Swamp Sparrow. A single bird was seen near Caborca on October 31 and November 1. Our best and repeated efforts to collect it failed.

Melospiza melodia. Song Sparrow. Although not previously recorded so far southwest in the Gulf lowlands, Song Sparrows are both residents and winter visitants near Caborca, where we found them quite common. The *montana* type was only slightly outnumbered by the redder *fallax* type. Our seven specimens include two *montana*, one of which is of the pale variety breeding in Nevada; an immature female *fisherella* was taken on October 30, which constitutes a new record for Sonora and, indeed, for Mexico; a young male *saltonis* taken the same day, is the southernmost record for that race; and three birds evidently represent the breeding population, which is also represented by a breeding male in the senior author's collection taken on an earlier trip to Caborca with van Rossem.

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FROM FIELD AND STUDY

Female Franklin Grouse in meadow three miles west of Payette Lake, 5400 feet, Adams County, Idaho, July 4, 1932. Photograph by Robert T. Orr.

Striped Cuckoo Fed by Rufous-and-white Wren in Panamá.—Evidence of the Striped Cuckoo (*Tapera naevia*) parasitizing small passerines is not lacking. Wetmore (Bull. U. S. Nat. Mus., 133, 1926:189) has summarized reports of *Synallaxis spixi* being victimized, while Naumburg (Bull. Am. Mus. Nat. Hist., 60, 1930:167-168) records a nest of *Schoeniophylax phryganophila* containing a young Striped Cuckoo.

On July 31, 1949, while staying at Boquete, Chiriquí, Panamá, my wife reported seeing a wren feeding red berries to a much larger streaked brownish bird with a mobile crest. Two days later, in the same bushy field at the edge of the village, I was fortunate enough to find a young Striped Cuckoo sitting on a brush heap where a Rufous-and-white Wren (*Thryothorus rufalbus*) was giving it a red berry about one centimeter in diameter. At intervals of about five minutes the wren would return from heavier growth across a nearby stream, always carrying a berry. Invariably, at the approach of its foster parent, the cuckoo would raise its crest and extend its wings, showing the blackish alulae. Except for an immaturely shaped bill it appeared to be almost fully grown, and it easily flew off when after an hour I attempted to catch it.

Having been familiar in life with both this cuckoo and this wren for fifteen years, I have no doubt as to the identity of either species. The dull-colored *Thryothorus modestus* was also common at Boquete. I am equally certain the foster parent with its conspicuous white superciliary was not *Synallaxis albescens* or any of the other local Furnariidae, the family which has supplied most of the previously recorded victims of *Tapera*.—Frederick W. Loetscher, Jr., *Department of Biology, Centre College, Danville, Kentucky, November 22, 1951.*

The Arizona Crested Flycatcher in Nevada.—On July 19, 1951, while in the southeastern part of Clark County, Nevada, at the tip of the state bordering on California and opposite the site of old Fort Mohave, Arizona, a pair of crested flycatchers was heard. These birds were gradually

working overhead, some 30 to 40 feet high, through the denser foliage of a cottonwood-willow association. When a glimpse of them was obtained, they appeared larger than the Ash-throated Flycatcher (*Myiarchus cinerascens*), a common summer resident of the area. One of the two birds was collected and proved to be an Arizona Crested Flycatcher (*Myiarchus tyrannulus magister*). It was an adult male with gonads fully developed.

Another Crested Flycatched was obtained on August 18, 1951, in an area at least a mile and a half from that in which the birds were first found on July 19. This specimen again proved to be an adult male but of paler coloration.

In the early afternoon of September 17, 1951, the observer drove through this area. Only three *Myiarchus* were seen at this hour; two were identified as *tyrannulus*, the other was not closely seen. No specimens were collected, however, at this time. It is believed that at least two pairs of crested flycatchers were breeding in the area.

It is remarkable that this species has been reported so seldom in the lower Colorado River Valley. Its occurrence has been reported only from south of the Fort Mohave area and to the east of it, in the Big Sandy Valley of Mohave County, Arizona. The southern records are from Bard, California, by Dickey (Condor, 24, 1922:134); from the Parker and Bill Williams Delta areas, Arizona (Monson, Condon, 51, 1949:264); and from Topock, Arizona (Monson, personal correspondence, 1951). The birds taken by me, although just within the boundary of the state, are first records of the occurrence of this species in Nevada.—WARREN M. PULICH, *Boulder City, Nevada, December 5, 1951.*

Feeding Behavior of Golden Plover in Captivity.—A Golden Plover (*Pluvialis dominica*) was captured alive at Carmel, California, on November 4, 1950, and kept in captivity for eight days. It had an injured wing and was unable to fly.

At first the bird was force-fed with earthworms. By November 6, two days after capture, the plover would watch my hand holding a worm above the cage and would immediately peck at the worm when it was held against the wire mesh.

On November 7, the bird was transferred to a larger cage, about three feet square and of the same height, with a sprinkling of sand on the floor. When the small dish which had been customarily used for food in the small cage was being carried through the open door of the new cage, the plover rushed toward it in obvious anticipation of food. On this day the following items of live food were presented and eaten: earthworm, sow bug (*Porcellio*), earwig (*Forficula*), and a small black beetle. The plover would pinch a live earwig in its bill, then flip it so that the insect was thrown off, then recover it. This process was repeated several times before the earwig was swallowed. When presented with an earthworm and a sow bug simultaneously, the worm was devoured first. The bird occasionally uttered a two-parted call note.

On November 8 the plover pecked at a rolled-up pill bug (*Armadillidium*), flipped it from its bill, then retrieved it. A snail (*Helminthoglypta*) was presented. The bird pecked at some part of the snail's body which was protruding from the shell, then flipped the snail vigorously from the bill. This tore the body apart. Most of the body, free of the shell, was thrown to the other side of the cage where the bird went for it, pecked it a little, then ran after and captured a crawling sow bug. Later the plover returned to the dislodged part of the snail's body and swallowed it. During the course of the day the double call note was heard several times. Once the bird poked its bill into the earth on the food dish (a sprinkling of soil was usually kept in the food dish to maintain earthworms), then dipped the bill in the water dish, apparently to clean it.

On November 9 the plover ate a beetle (*Pterostichus*). It picked this insect, still alive, from between the points of a pair of bird banding pliers held out to it, flipping the beetle twice before swallowing it.

On November 10 a salamander (*Batrachoseps*), about 70 mm. in length, which was more or less torpid when collected, wriggled violently when pecked by the plover, resulting in the disjunction of the amphibian's tail. This the plover swallowed. A pill bug, rolled up, was taken from the hand and swallowed. The bird by this date had become conditioned to take readily a variety of foods from the hand.

On the morning of November 12 the plover was found dead on the floor of the cage. Upon dissection the specimen proved to be a male. The skin was presented to the Museum of Vertebrate

Zoology (no. 122453). Subspecific determination was made by Alden H. Miller and Frank A. Pitelka, who agreed that the specimen was of the race *P. d. fulva*, "not possessing all the characters which that race displays, but certainly closer to typical *fulva* than to *dominica*" (Pitelka, *in litt.*).—LAIDLAW WILLIAMS, *Carmel, California, November 6, 1951.*

The Earliest Name of the Korean Tree Sparrow.—*Passer montanus orientalis* was based by A. H. Clark (Proc. U. S. Nat. Mus., 38, 1910:69) on "a specimen from Hakodate [Hokkaido] . . . and two males from Fusan [Korea]"; it was alleged to differ from *Passer m. montanus* by its somewhat stouter bill.

Since the birds of Hokkaido and of Korea are no longer considered consubspecific, some reviser might have been expected by now to have fixed Clark's name upon one or the other population. That Hartert (Vögel der paläarktischen Fauna, 3, 1921:2071) failed to take such action may be explained by his assumption that *saturatus* Stejneger, 1885, was the name applicable to birds of all Japan and Korea, with *orientalis* its synonym. The Ornithological Society of Japan has, in its latest editions of "A Hand-list of the Japanese Birds," 1932 and 1942, given *kaibatoi* Munsterhjelm, 1916, for the race of Hokkaido, and *dybowskii* Domaniewski, 1915, for the one of Korea, under each name listing *orientalis* Clark, 1910, *partim*, as a synonym. Austin ("Birds of Korea," 1948:249), calling Korean birds *dybowskii*, has similarly treated *orientalis, partim*, as a synonym. All these authors seem to have labored under a misapprehension that a name based upon a composite series is forever invalid.

Since, to my knowledge, no reviser has yet fixed Clark's name upon either population, I now restrict the type locality of *Passer montanus orientalis* Clark, 1910, to Pusan, South Kyongsang Province, Korea. The cotypes are United States National Museum nos. 114228 and 114229.

For several excellent reasons, I should have preferred to make Hokkaido the *terra typica*, but reconstruction of the original series of *orientalis* has shown that such restriction is not permissible. Although the fact was not indicated by Clark, his Hokkaido skin (U.S.N.M. no. 201530) is a juvenal male, with bill scarcely developed to half the proportions shown by the two adult males from Korea; since it is too young to show the only character adduced by Clark for his new form, it cannot possibly be set aside as the type of the name.

With *orientalis* Clark, 1910, made definitely applicable to the bird of Korea, *dybowskii* Domaniewski, 1915 (Ussuriland and Korea) becomes its synonym.—H. G. DEIGNAN, *United States National Museum, Washington, D.C., December 19, 1951.*

Some Bird Records from the Cariboo District, British Columbia.—The publications by Munro (Canad. Jour. Res., D 23, 1945:17-103) and Munro and Cowan (Brit. Columbia Prov. Mus. Spec. Publ. No. 2, 1947:1-285) have provided a sound basis for the study of the distribution of the bird fauna of the Cariboo district of central British Columbia. Recent work there by the present writer has resulted in the extension of some ranges, an increased knowledge of the local status of certain species and the taking of a few species not previously known to enter the district.

Micropalama himantopus. Stilt Sandpiper. A male taken at 153 Mile on the Cariboo Road on September 5, 1951, is the first record for the region.

Strix varia varia. Barred Owl. On September 8, 1946, I photographed the first Barred Owl recorded for central British Columbia. This photograph of a young bird served as the basis for the addition of the species to the provincial avifauna west of the Rocky Mountains (Munro and Cowan, *op. cit.* :131).

Since then much more information on the status of the species has accumulated and two specimens have been obtained. The first of these, a young female, was taken near Likely, on October 2, 1949. The second, received on October 5, 1951, from W. Gill of Prince George, marks an extension of range 150 miles north of the nearest previous locality.

Inquiries of foresters and trappers in the region northeast of Williams Lake lead to the conclusion that the Barred Owl is of reasonably common occurrence there. Observations by Forest Ranger K. Paterson and myself 14 miles northeast of Likely in May, 1951, led us to believe that the Barred Owl was nesting in the vicinity.

Sphyrapicus varius ruber. Red-breasted Sapsucker. The southernmost record of this type of sapsucker in the interior of British Columbia has been Indianpoint Lake (Munro and Cowan, *op. cit.*: 141). I have taken a juvenal specimen and seen both adults and juveniles along the Beaver Valley road near Horsefly, in July, 1951.

Picoides arcticus. Arctic Three-toed Woodpecker. Not previously recorded from the Cariboo Parklands but now known to occur as a winter visitant. Specimens were taken at Williams Lake on December 24, 1949, and on January 11, 1951.

Picoides tridactylus fasciatus. American Three-toed Woodpecker. Not previously known from the Cariboo, but like the last, occurs as a winter visitant, with some individuals remaining throughout the year at higher elevations. Specimens taken at Williams Lake on January 12, 1951.

Euphagus carolinus. Rusty Blackbird. This species has been reported as a transient in the area but has not been known to nest there. On July 20, 1951, I collected a young bird, still being fed by the parents, at Likely and saw other birds on the same date at Spanish Lake, seven miles north of Likely.—Leo Jobin, *Williams Lake, British Columbia, December 10, 1951.*

Comments on the Check-list of the Birds of Idaho.—The note by Porter (Condor, 53, 1951: 257-258) on the rough-legged hawks in Idaho has emphasized the need for an explanation of the status of our knowledge of the birds of that state. Arvey (Univ. Kansas Publ., Mus. Nat. Hist., 1, 1947:193-216) presented a check-list of Idaho birds which does not represent an adequate summarization of known facts. His list recorded 265 species (minus Hutton Vireo, see Arvey, Condor, 52, 1950:275). In his preface he stated "In all, 292 kinds of birds are recorded." Of this total, the accounts of approximately one-fourth are quite inaccurate. Examples of inaccuracies still uncorrected by Arvey (*op. cit.*, 1950):

Species that breed in Idaho but were not indicated as doing so: Red-necked Grebe, Redhead Duck, Ruddy Duck, Lesser Scaup Duck, Ferruginous Rough-legged Hawk (corrected by Porter, *op. cit.*), Willet and Wilson Phalarope.

Species indicated as breeding but which are not now known to: Common Loon, Horned Grebe, American Golden-eye Duck, American Rough-legged Hawk, Northern Phalarope, Gray-crowned Rosy Finch, and Tree Sparrow.

Species for which the status was not defined at all: Red-breasted Merganser, Harlequin Duck (Arvey misidentified two juveniles of this species taken on the St. Joe River by Engler; Arvey, MS 1940:9), and Band-tailed Pigeon.

Species for which the status is confused or in error: Rough-winged and Bank swallows, Raven, Ruby-crowned Kinglet, and Water-thrush (to cite only a few of about 50 species).

Species indicated as occurring in the state in the bibliography but not in the text: Upland Plover, Least Tern, Western Flycatcher, Eastern Blue Jay (Arvey's own note), Grasshopper Sparrow, McCown Longspur.

Species overlooked in the literature: Parasitic Jaeger, Ancient Murrelet.

Species omitted but known to Arvey: Mountain Plover.

Typographical errors: the subspecies *phaia* and *umbelloides* of the Ruffed Grouse are switched; the range of *phaia* is with *umbelloides* and vice versa.

The many inadequacies of Arvey's list and the addition of about twenty species make it imperative that another check-list be prepared. Such a check-list was begun three years ago and a mimeographed preliminary version was distributed. This mimeographed list was at the disposal of Levy for his account of the birds of southern Idaho (Murrelet, 31, 1950:2-8) and of Arvey for his correction of the original check-list (*op. cit.*, 1950).

Regarding the note by Porter, it should be pointed out that the Ferruginous Rough-leg was generally assumed to breed in southern Idaho as this area lies in about the middle of the breeding range of this species. The only earlier reference to summer residence in Idaho of which I am aware is that of Kenagy (Condor, 16, 1914:120). Kenagy, as an egg collector, probably observed the nest of this species on several occasions in the Rupert area.

Porter's views regarding the abundance of this species are open to question. At best it is only locally common (pair seen regularly in the vicinity of a nest), not common in terms of birds per unit area of country. In 1949, Earl Larrison and I spent one week in the juniper country of Cassia

County and did not once record this species although I do not doubt that it does occur sparingly there.

The comments of Weydemeyer (Condor, 35, 1933:121), cited by Porter, concerning the breeding of the American Rough-legged Hawk in northwestern Montana are not verified by specimens nor do they sound convincing to me (identification of two "young" birds on the wing on August 8, 1922). It would seem to me that Swainson Hawks are probably referred to (I have seen them myself in similar situations in northern Idaho). There is no real evidence to extend the breeding range of the American Rough-leg into northern Idaho or northwestern Montana.—MALCOLM JOLLIE, *University of Idaho, Moscow, Idaho, January 12, 1952.*

Song in Hand-reared Birds.—The present writer has twice written on the subject of song in hand-reared birds, although the statements have been brief. In 1921 (Condor, 23:43) the call note and the first song or tribal song of the House Finch or Linnet (*Carpodacus mexicanus*) were both considered to be inherited and free from the influence of associated sounds. That the more finished performance of the adult male might be modified by association was conceded to be possible or even probable.

Some years later I became acquainted with a hand-reared male Linnet in Los Angeles which was so very aberrant in its song as to lead me to comment as follows (Condor, 31, 1929:221): "He was struggling with a voluble performance that was all his own! It was not like any other bird song I ever heard, and was apparently not imitated." This bird was a great pet that had only human associates who fed him any and everything that he could be induced to take from the hand or from the table. It was known to the indulgent household as "Tweetie."

Since publication of this second note my attention has been more carefully directed to the subject of the linnet's notes in the field with the result that one wild male was heard at El Segundo, California, who had in his song a tone quality that duplicated the tone, as registered by the ear, which characterized "Tweetie's" vocal efforts. It is the only wild linnet that I have ever heard produce such a tone. The song pattern, however, was that of the average wild bird.

"Tweetie" did not live to a ripe old age on his highly artificial diet and was sent to me to be converted into a specimen showing the yellow plumage induced by cage conditions. The body was found to be markedly pathologic, with nodular masses of fatty tissue unevenly distributed beneath the skin and among the viscera. Unfortunately a microdissection of the syrinx was not made.

After the passing of "Tweetie," a hand-reared linnet was presented to me by a student. This bird, "Ricardo," was of course in yellow plumage but seemed to be in quite normal health although perhaps slightly less than normal in size. Ricardo was fed only on commercial bird seed with addition of fresh lettuce, dandelion, and fruits. His song was voluble and it almost perfectly duplicated that of wild birds. It was carefully noted by myself and by one of my equally critical colleagues in ornithology but we could see no greater aberration than is evident in shifting from one local population to another in southern California. Unfortunately I have no subsequent history of this bird since he died in my absence from Los Angeles. It had, however, been under observation for a number of months.

W. E. D. Scott (Science, n.s., 14, 1901:524-526) indicates that hand-reared Baltimore Orioles did not sing the oriole's song. Mrs. M. M. Nice informs me that her hand-reared meadowlarks do not sing the normal song of the species. I would suggest that both orioles and meadowlarks are perhaps more difficult to handle in dietary matters than is the fairly strictly vegetarian linnet or of course the long domesticated "canaries" of the pet trade. I am strongly tempted therefore to postulate that the aberrant vocalizations of certain cage bred individuals of native species are possibly due to malformations resulting from our inability to duplicate the normal diet and the tireless devotion of normal parents in their upbringing. The "miracle" is that we sometimes achieve so nearly natural results in that delicately balanced, anatomic, physiologic, and psychologic complex that blossoms into the bird's natural song.—LOVE MILLER, *Museum of Vertebrate Zoology, Berkeley, California, June 5, 1951.*

Current Status of the Starling in North-central Colorado.—While the Starling (*Sturnus vulgaris*) continues to expand its range into the Pacific Coast states, it appears to have settled permanently in Colorado. The first record of the species in this state was in 1938, the first positive breeding

report in 1943. The following information on its status in Boulder and Larimer counties is probably indicative of its success throughout eastern Colorado.

I reported the first breeding record from Boulder County (1948) in a plains cottonwood river bottom (Condor, 51, 1949:97). In censusing this same area in the spring of 1951, seven nesting pairs were observed, although the original nest cavity was unoccupied. On St. Vrain Creek, twelve miles north of the Boulder site, another active nest was observed in 1951 in a cottonwood grove.

The history of the bird's establishment in Larimer County is more complete. In the Fort Collins region in the Christmas period of 1947 no Starlings were reported. In 1948 flocks arriving on December 23 totaled 483 individuals. In 1949 around Fort Collins 243 were counted on December 29, while 42 were seen on December 29, 1950. Breeding records show a similar trend. At a cottonwood river bottom three miles southeast of Fort Collins, no Starlings were observed in the spring of 1949. In 1950 Starlings were seen in this area on six out of seventeen spring field trips, but there were no nesting records. The following spring, however, four nesting pairs were established in the same area. Another active nest was noted in a cottonwood grove at the entrance to Spring Canyon, four miles southwest of Fort Collins, in 1951.

In most cases nest cavities occupied were known to have been used in past years by either Red-shafted Flickers or Red-headed Woodpeckers.—R. G. Beidleman, *Department of Zoology, Colorado A. and M. College, Fort Collins, Colorado, November 19, 1951.*

Additional Bird Records for Nevada.—In the years 1948 through 1951 many field observations of birds were made by the author in the northern half of Nevada. The few presented below are the more unusual of these observations, and they provide additions to the cumulative knowledge of occurrence of Nevada birds as represented in papers by Linsdale (Pac. Coast Avif. No. 23, 1936), Alcorn (Condor, 48, 1946:129-138), Gabrielson (Condor, 51, 1949:179-187), Marshall (Condor, 53, 1951:157-158) and Linsdale (Condor, 53, 1951:228-249).

Falco peregrinus. Peregrine Falcon. On June 23, 1949, a nest was found in a 200-foot cliff along the North Fork of the Humboldt River in Elko County. Both adults remained in the vicinity of the nest.

Charadrius alexandrinus. Snowy Plover. Since Linsdale (*op. cit.*, 1951:233) still lists the Snowy Plover as a "transient," it should be of interest that one downy young was seen with a flock of 35 or 40 adults on mud flats at the edge of Fernley Sink in Lyon County on August 30, 1949. In Pershing County, on this same date, a flock of about 300 adults was seen in Toulon Sink. Observation of this downy young provides the first evidence of the breeding of this species in Nevada. Marshall (*op. cit.*, 1951:157) reported large numbers in the Carson Sink in recent summers, and recent correspondence with him revealed that he has nesting records for that area for 1951 which he has not yet published.

Sphyrapicus thyroideus. Williamson Sapsucker. A pair with a nest hole at a height of about 28 feet on the north side of a tall alder was found near Twin Bridges on the South Fork of the Humboldt River, Elko County, on June 21, 1949.

Cyanocitta stelleri. Steller Jay. Two were seen on the east slope of the Desatoya Mountains, Lander County, on June 24, 1949.

Parus atricapillus. Black-capped Chickadee. At noon on October 10, 1950, several of these chickadees were watched at close range about picnic tables in the municipal park at Fallon, Churchill County. Since I was then unaware of the unusualness of this observation, no attempt was made to count them.—Fred G. Evenden, Jr., *U. S. Fish and Wildlife Service, Sacramento, California, May 25, 1951.*

The Types of Lambrecht's Fossil Bird Genera.—In his Handbuch der Palaeornithologie (1933) the late Kálmán Lambrecht erected 29 new generic names for fossil birds. With few exceptions designation of the type species was omitted, although the publication appeared after December 31, 1930, the date from which the International Rules of Zoological Nomenclature require such designation. The genera for which Lambrecht designated the types are as follows:

Parascaniornis, p. 335, fig. 116. Type *Parascaniornis stensiöi* Lambrecht, 1933, designated on p. 338.

Rallicrex, p. 463. Type *Rallicrex kolozsvárensis* Lambrecht under the new genus—new species convention (see Opinion 7, International Rules).

Pliogrus, p. 522. Type *Pliogrus germanicus* Lambrecht, under the same convention.

The following genera are monotypic and take their only included species as types:

Paracorax, p. 292, fig. 104C. Type *Phalacrocorax destefanii* Regalia, 1902.

Proardea, p. 311. Type *Ardea amissa* Milne-Edwards, 1891.

Palaeoaramides, p. 462. Type *Rallus christyi* Milne-Edwards, 1871.

Paraortygometra, p. 462. Type *Rallus porzanoides* Milne-Edwards, 1871.

Pararallus, p. 466. Type *Rallus dispar* Milne-Edwards, 1871.

Miorallus, p. 466. Type *Rallus major* Milne-Edwards, 1871.

Fulicaletornis, p. 479. Type *Aletornis venustus* Marsh, 1872.

Miofulica, p. 480. Type *Fulica dejardini* Van Beneden, 1872.

Moreno-merceratia, p. 512, fig. 149D. Type *Palaeociconia cristata* Moreno and Mercerate, 1891.

Probalearica, p. 519. Type *Grus problematicus* Milne-Edwards, 1871.

Paragrus, p. 520. Type *Gallinuloides prentici* Loomis, 1906.

Gerandia, p. 602. Type *Columba calcaria* Milne-Edwards, 1871.

Archaeopsittacus, p. 609. Type *Psittacus verreauxi* Milne-Edwards, 1870.

Paratrogon, p. 626. Type *Trogon gallicus* Milne-Edwards, 1871. This new generic name was omitted from the Zoological Record.

Miocorax, p. 636. This name for a crow is preoccupied by Lambrecht's use of the same name for a cormorant on p. 291. It was corrected under Druckfehler, p. 1024, to read *Miocorvus*. The correction was overlooked by the editor of the Zoological Record. Type *Corvus larteti* Milne-Edwards, 1871.

The following genera were treated as polytypic by Lambrecht (1933). As first reviser I fix their types as follows:

Oligocorax, p. 290, fig. 104A, 104B. Although designated as a new genus, this name really dates from Lambrecht, 1931 (Proc. VII Ornith. Congr. Amsterdam, 1930:80). Type *Graculus littoralis* Milne-Edwards, 1868.

Miocorax, p. 291, fig. 178. Type *Phalacrocorax femoralis* Miller, 1929.

Australocorax, p. 293, fig. 104E. Contains two species according to Lambrecht (1933), but the name really dates from Lambrecht's paper given at the Amsterdam Congress (1931). In this place it is monotypic, and the type is *Phalacrocorax vetustus* De Vis, 1906.

Aquilavus, p. 407. Type *Aquila depredator* Milne-Edwards, 1871.

Archaeophasianus, p. 438. Type *Phasianus roberti* Stone, 1915.

Miophasianus, p. 439. Type *Phasianus altus* Milne-Edwards, 1871. This new generic name was omitted from the Zoological Record.

Miogallus, p. 442. Type *Gallus longaevus* v. Ammon, 1918, the other included form being a species inquirenda.

Quercyrallus, p. 461. Type *Rallus arenarius* Milne-Edwards, 1891.

Protogrus, p. 520. Type *Aletornis nobilis* Marsh, 1872.

Palaeopicus, p. 629, fig. 172A. Type *Picus archiaci* Milne-Edwards, 1871.—PIERCE BRODKORB, *Department of Biology, University of Florida, Gainesville, Florida, November 17, 1951.*

Occurrence of the Skua in Southern California.—On April 4, 1951, I observed an immature Skua (*Catharacta skua*), at 4:30 p.m., resting on the beach just north of the Santa Monica pier, Santa Monica, California. The bird was sitting apart from a large group of California and Heermann gulls. It seemed tired, as when forced to fly it would make a short circle and then on landing sit down in the sand again. The Skua stayed on the beach with the gulls and would not stand up for more than a few minutes in the course of the entire half hour it was observed. The gulls did not show fear of the Skua's presence.—WILLIAM R. LASKY, *Santa Monica, California, July 30, 1951.*

NOTES AND NEWS

Harold M. Holland, member of the Cooper Ornithological Club since 1901.

Ornithology the world over sustained a great loss in the death of James L. Peters on April 19 of this year. Mr. Peters was held in high regard for his 7 volumes on the Birds of the World. He was president of the International Commission on Zoological Nomenclature, Curator of Birds at the Museum of Comparative Zoology at Harvard University, past president of the American Ornithologists' Union and for many years editor of Bird-Banding.

After four years as Treasurer of the Cooper Ornithological Club, Sidney B. Peyton has asked to be relieved of the very considerable burden of this post. Jack C. von Bloeker, Jr., of 161 West 121st St., Los Angeles 61, California, succeeds him. The sincere gratitude of our organization is extended to Mr. Peyton for his devotion to this important job. He has contributed a service of major proportion which will long be appreciated by our large membership.

Important new publications recently received are Finn Salomonsen's "The Birds of Greenland," Part III, the concluding section, and Harold S. Peters and Thomas D. Burleigh's "The Birds of Newfoundland," the latter very attractively illustrated by Roger Tory Peterson.

COOPER CLUB MEETINGS

SOUTHERN DIVISION

FEBRUARY.—The monthly meeting of the Southern Division of the Cooper Ornithological Club was held on February 26, 1952, at the University of Southern California. The following names were proposed for membership: Miss Jean Burch, 43 Douglas Road, Belmont 78, Mass., by Wendell Taber; Hugh D. Byrne, 2529 W. Ave. 33, Los Angeles 65, Calif., by Kenneth Stager; Dr. Wallace Rogers, 715 Ellsworth Dr., N.W., Atlanta, Georgia, by Earle Greene; Jack A. Smalley, 1891 Denison St., Pomona, Calif., by J. McB. Robertson; Marquess Hachisuka, Shizuoka Ken, Atami, Japan, and Marquis Yoshimaro Yamashina, 49 Nampeidai-Machi-Shibuya-Ku, Tokyo, Japan, by Mrs. J. Q. Burch; Jerram Lefevre Brown, 19 Hitchcock Road, Amhurst, Mass., Leonard Hall, Possum Trot Farm, Caledonia, Mo., Dr. M. Max Hensley, Dept. of Biology, Gettysburg College, Gettysburg, Penn., Holger Holgerson, Stavanger Museum, Stavanger, Norway, Edgar B. Kincaid, Jr., 702 Park Place, Austin, Texas, Ronald H. Mackay, Dept. of Zoology, Univ. of B. C., Vancouver, B.C., Martin Mees, Koningen Emmaplein 7, Rotterdam, Netheralnds, Mrs. Monta A. Mills, 1091 Bush St., Apt. 312, San Francisco, Calif., Miss Clelia A. Paroni, 575 Vicente Ave., Berkeley 7, Calif., Dr. Robert L. Rauch, Box 960, U. S. Public Health Service, Anchorage, Alaska, Marie E. Sterne, 3027 Benvenue Ave., Berkeley 5, Calif., Mrs. Sophie Stubgen, 48 Highgate Rd., Berkeley 8, Calif., and J. Troy Towe, Rt. 5, Box 143, Mt. Airy, N. C., all by C. V. Duff.

Kenneth Stager reminded members of the nesting survey being conducted by the Research Committee on certain birds in the Los Angeles area.

Observations by members brought numerous reports of Townsend Solitaires seen in lowland areas in the month of February. Bob Pyle reported two White-winged Doves that had been in Los Angeles since November. He also reported a Tufted Puffin and a Blue-winged Teal seen at Playa del Rey on February 24. Wade Fox observed that Horned Grebes were more numerous in southern California this winter than formerly.

William Norman Jupe of Palm Springs presented a series of colored motion pictures, entitled "Bird Portraits."—DOROTHY E. GRONER, *Secretary*.

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For Sale, Exchange, and Want Column—Each Cooper Club member is entitled to one short advertising notice in any issue of the Condor free. Notices of over 3 lines will be charged for at the rate of 25 cents per line.

FOR SALE OR EXCHANGE—Condor, vols. 2 and 3 (unbound); vols. 11-14 (bound). The Auk, vol. 15, no. 1; vol. 18, complete (amateur binding); vol. 51, no. 1. WANTED—Auk, vols. 32-41; Auk indices for vols. 18-57. Please make offer.—ROBERT W. STORER, *University of Michigan Museum of Zoology, Ann Arbor, Michigan.*

FOR SALE—Condor, vol. 1, no. 5; vol. 3, no. 4; vol. 4, no. 1; vol. 6, no. 2; vol. 7 to vol. 43 complete; vol. 44, nos. 1, 2, 3, 4, 5; vol. 47, nos. 3, 4, 5, 6; vols. 48 and 49 complete. The lot, $100.00 f.o.b. San Diego. Bendire's Life History of N. A. Birds, 2 vols. (needs binding), $8.00. Jour. Mammalogy, vol. 1 complete; vol. 2, nos. 1, 3; vol. 3 complete; vol. 4 complete; vol. 5, no. 4; vol. 6 complete. The lot, $40.00. Bent's Life Histories, 107, 113, 121, 126, 130, 135, 142 (damaged), 146. The lot, $90.00. North American Recent Mammals, 1923 by Miller, $2.50. Coues' Key to North American Birds, 5th edition, 2 vols., $7.50. Pliocene and Pleistocene Mollusca of California by Grant and Gale, $5.00. Postage extra.—L. M. HUEY, *Natural History Museum, Balboa Park, San Diego 1, California.*

FOR SALE—Books on Ornithology, Falconry, and other natural history subjects. Send for catalogue. Books purchased for cash or trade; let us know what you have to dispose of.—W. R. HECHT, *3965a Shenandoah, St. Louis 10, Missouri.*

FOR SALE—.38 caliber Smith and Wesson revolver with 7-inch smooth bore barrel for bird shot. Included is a rifled barrel and holster and belt. All in excellent condition. $60 postpaid.—HENRY E. CHILDS, JR., *Experimental Range, O'Neals, California.*

FOR SALE—I am disposing of my Ornithological library and offer the following: Bulletin of the Nuttall Ornith. Club: vols. 1 and 2 unbound, vols. 3 to 8 bound, complete. The Auk, complete set to date: vols. 1 to 55 bound, balance unbound. The Condor, complete set: vols. 1 to 37 bound, balance unbound. The Wilson Bulletin, complete set: nos. 1 to 32 bound, balance unbound. The Oologist (forerunner of the Ornithologist and Oologist): vols. 3, 4, and 5 bound. The Ornithologist and Oologist: vol. 6 (lacks no. 6 and no. 12) unbound, vols. 1 to 18 complete, bound. The Osprey: vols. 1 to 6 complete, bound. The Warbler: Second Series, vols. 1 to 7 complete, bound. The Nidologist: vols. 1 to 4 complete, bound. The Oologist: complete file, vols. 1 to 51 bound, balance unbound. Journal of the Maine Ornith. Society: complete, vols. 1 to 13 bound. Bird Lore and Audubon Magazine: complete file, vols. 1 to 15 bound, balance unbound. American Ornithology: complete, vols. 1 to 6, bound. Sets will not be broken. Write for prices if interested.—DR. W. I. MITCHELL, *398 Vassar Ave., Berkeley 8, California.*

THE CRANBROOK INSTITUTE OF SCIENCE, in order to reduce inventory, is offering substantial reduction in price on several of its ornithological publications for a limited time only. The following are available (the present postpaid price precedes the old price in parentheses). Walkinshaw, The Sandhill Cranes, $2.00 ($3.50). Storer, The Flight of Birds, $1.75 ($2.50). Hatt, Van Tyne, *et al.*, Island Life in Lake Michigan, $2.75 ($4.00). Sutton, Juvenal Plumage of Sparrows, 25¢ (50¢).—*Bloomfield Hills, Michigan.*

PREPARATION OF MANUSCRIPTS FOR THE CONDOR

Articles published in the Condor normally are written by members of the Cooper Ornithological Club. Practically all the Club's money goes into the journal; no editor or business manager receives any pay other than the satisfaction of doing a service worthily. The preparation of good copy by the author will contribute greatly to accuracy of published output, dispatch in handling, and economy of production.

To be acceptable for inclusion in the Condor, articles must not duplicate in any substantial way material that is published elsewhere. Any type of subject bearing on birds may be considered; but the geographic areas of primary concern are western North America, Central America, and the Pacific Basin. Manuscripts may be sent to the editors at the Museum of Vertebrate Zoology. Proofs with edited manuscripts will be sent to authors, at which time reprints may be ordered.

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